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D'INFORMATION
SUR LES RESSOURCES
GÉNÉTIQUES ANIMALES**

**BOLETÍN
DE INFORMACIÓN
SOBRE RECURSOS
GENÉTICOS ANIMALES**



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BOLETÍN DE INFORMACIÓN SOBRE RECURSOS GENÉTICOS ANIMALES

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Editorial - Thematic Studies

As a contribution to the first Report on the State of the World's Animal Genetic Resources, special thematic studies have been completed by organizations or expert groups. They will be an integral part of the Report. Many of these papers have printed versions that can be obtained by browsing the DAD-IS library (www.fao.org/dad-is). A list of the papers, only available in English, follows.

The Editors

Editorial - Estudios temáticos

Como contribución al primer Informe Mundial sobre los Recursos Zoogenéticos, varios estudios especiales han sido realizados por organizaciones y grupos de expertos. Estos estudios formarán parte del Informe. Existen versiones finales de muchos de estos trabajos, que pueden obtenerse en la biblioteca del DAD-IS (www.fao.org/dad-is). Se incluye la lista de trabajos, disponibles solo en inglés.

Los Editores

Éditorial - Études thématiques

Comme contribution au premier Rapport sur l'état des ressources zoogénétiques dans le monde, plusieurs études thématiques ont été spécialement réalisées par des organisations et groupes d'experts et seront publiées dans ce Rapport. Un grand nombre parmi ces travaux sont accessibles à partir de la bibliothèque DAD-IS (www.fao.org/dad-is). Une liste des articles, uniquement en anglais, est présentée ci-dessous.

Les Editeurs

List of Thematic Studies for the *First Report on the State of the World's Animal Genetic Resources*

Recent developments in biotechnology related to animal genetic resources for food and agriculture. A position paper on biotechnologies and their impact on use of livestock genetic diversity.

Measurement of domestic animal diversity (MoDAD); review of recent diversity studies. A survey to evaluate the current status of molecular genetic research focusing on characterization.

Opportunities for incorporating genetic elements into the management of farm animal diseases: policy issues. A review paper on the potential of genetics in the management of disease.

The economics of farm animal genetic resource conservation and sustainable use: Why is it important and what have we learned? A study on valuation of animal genetic resources.

Conservation strategies for animal genetic resources. A study contrasting plant and animal genetic resources: opportunities, challenges, institutional and operational considerations.

Legal issues for the management of animal genetic resources. An introductory study on policy and legal framework including a survey of countries in different world regions.

Environmental effects on animal genetic resources. A study to evaluate on environmental factors and their effects on animal genetic resources at individual and population levels.

People and animals. Traditional livestock keepers: Guardians of domestic animal diversity. A documentation of 13 case studies on how communities manage their local animal genetic resources.

The state of development and potential of biotechnologies related to management of farm animal genetic resources. An introductory

study on biotechnology applications and their use in developing countries based on information provided in Country Reports.

Gene flow in animal genetic resources. A study on status, impact and trends. A study on the magnitude and direction of movement of genetic material in cattle, pigs, goats, and sheep.

Options and strategies for the conservation of farm animal genetic resources. The results of an international Workshop held in Montpellier, France, from 7 to 10 November 2005.

Exchange of animal genetic resources: current practices and their effect on stakeholders in the livestock sector. A study to identify how exchange practices regarding animal genetic resources affect the various stakeholders in the livestock sector.

The impact of disasters and emergencies on animal genetic resources. A review of possible disasters that may have an impact on animal genetic resources and livestock diversity.

Animal genetic resources and traditional farming in Vietnam

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Summary

The main animal feed sources in Vietnam are rice bran, rice straw, sweet potato, sugar cane, garden by-product and natural grasses. The majority of the rural population are considered to be farmers, 75% of them practice animal husbandry of which 95% includes animal production with local breeds or crosses. Local breeds or crosses produce 80% of meat and 75% of eggs. Animal production accounts for 20-25% of the total agricultural production. Pork represents 70% of domestic meat consumption.

Low external inputs are associated with the use of natural resources. Such types of natural resources as local breeds of animal are highly respected and used in a sustainable way. Uriu cattle survived the mechanisation in rice production due to the fact that the rice fields of Nghe An are full of rocks. Dong Tao chicken keeping is increasing thanks to the gourmet tastes of exigent Vietnamese consumers. Bau Qui ducks were maintained by Vietnamese of Thai ethnic tradition who killed all animals different from their breeds coming from other parts of the Quy Chau mountains, while the I pig faced the risk of extinction due to the priority given to imported pig breeds for intensive production. The tenacious and strongly built Mong Cai pig is a feature of households in semi-intensive production.

residuos secos o paja del arroz, patata dulce, azúcar de caña, subproductos de horticultura y pastos naturales. La mayoría de las poblaciones rurales se consideran ganaderas, de las cuales el 75% se dedica a la cría ganadera y de éstos el 95% a la producción animal con razas locales o cruces. Las razas locales o sus cruces producen un 80% de carne y 75% de huevos. La producción animal representa un 20-25% de la producción agrícola total. El cerdo representa un 70% del consumo de carne.

Los aportes externos se asocian a la utilización de recursos naturales. Estos recursos naturales, tales como las razas locales de animales, están altamente respetados y utilizados de forma sostenible. La raza vacuna Uriu ha sobrevivido a la mecanización de la producción de arroz debido a que los campos de arroz de Nghe An presentan suelos altamente rocosos. La cría de los pollos Dong Tao se ha incrementado gracias al gusto exquisito de los consumidores vietnamitas que así lo requieren. La cría de patos de raza Bau Qui está en manos de los vietnamitas de origen tailandés que tradicionalmente sacrifican todos aquellos animales que no pertenezcan a las razas provenientes de las montañas de Quy Chau. Mientras que los cerdos corren el riesgo de extinción debido a la prioridad que se da a las razas de cerdos importados de producción intensiva. La tenacidad y fortaleza de la raza porcina Mong Cai es uno de los rasgos que resaltan los ganaderos de esta producción semi-intensiva.

Resumen

Los principales recursos alimentarios en Vietnam provienen de la cáscara de arroz,

Keywords: *Traditional farming, AnGR, Vietnamese agriculture, Feed resources, Pig breeds, Cattle, breeds, Poultry breeds, Conservation.*

Introduction

Geographical and social background of Vietnamese agriculture

Vietnam is a tropical country of lowlands, hills, mountains and forests. Its shape is an elongated 'S' form of 1 650 kilometres in length while the narrowest part of Central Vietnam is only 50 kilometres wide. It has about 80 million inhabitants inhabiting a total surface area of 331 688 square kilometres. Vietnam borders China (1 281 km) to the north, Laos (1 555 km) and Cambodia (982 km) to the west, and the Pacific Ocean (3 451 km) to the east and the south. Vietnam has a remarkably diverse climate because of its wide range of latitudes and altitudes. Although the entire country lies in the tropics and subtropics, local conditions vary from frosty winters in the far northern hills to the year-round, equatorial warmth of the Mekong Delta. Because about one-third of Vietnam lies more than 500 m above sea level, much of the country enjoys a subtropical or, above 2 000 m, even a temperate climate. The summer monsoon brings hot air from the Gobi Desert, accompanied by heavy rainfall. Most of Vietnam receives about 2 000-3 000 mm of rain annually. The two deltas, the Red River (15 000 square kilometres) in the north and the Mekong (60 000 sq km) in the tropical south, are the rice bowls providing for a fast-growing population. Vietnamese often describe their country as resembling a bamboo pole supporting a basket of rice on each end. The central region has large but diminishing forests, volcanic basalt soil, and profitable tea and coffee plantations (Le Ly, 1994).

Vietnam is dominated by the Viet ethnic group, which represents more than 88% of the total population. They coexist with more than 50 other ethnic groups, from Khmer to Chinese, from Thai to Hmong. A great number of these groups live in the central highlands or the northern border areas. (Le Ly, 1994). Most of the individual ethnic groups have a rural, agricultural lifestyle and

are semi-nomadic, cultivating crops such as "dry" rice using slash-and-burn methods, which have taken a heavy toll on the environment. Because such practices destroy the ever dwindling forests, the government has been trying to encourage them to adopt more settled agricultural practices often at lower altitudes, with wet (paddy) rice and cash crops such as tea, coffee and cinnamon. Still, despite the allure of benefits like subsidised irrigation, better education and health care, a long history of nonconformist attitudes, coupled with a general distrust of the lowland ethnic-Vietnamese majority, keeps many away from the lowlands

Main characteristics of agriculture in Vietnam

Due to significant population pressures (only 0.1 ha arable land per capita) Vietnam has had to put a high priority on the development of sustainable agriculture (Dong Xuan and Szalay, 2003) (**Figure 1**). The traditional farming base of Vietnam is an integrated system of rice, root crops, fruit, vegetables, livestock and poultry (Viet Ly, 1998).

Vietnamese Government encourages peasants to follow the VAC integrated farming system. VAC, 'Vuon-Ao-Chuong', means Garden-Pond-Shed. VAC is a well-known name in Vietnam and is a farming system linking the garden (crops), pond (fish) and shed (animal) together. Farmers build their bamboo pigsty above the pond dug at the back of the garden. While the ducks swim and feed in the pond, fishes profit from the feed residue of all. Finally, sewage-water is conducted to the garden as manure. This integrated household farming system functions in a closed circle of alimentation and manure and results in increases in income to smallholders in the countryside without destroying the environment.

The agriculture of Vietnam is based mainly on rice production. Most of Vietnam's



Figure 1. Traditional farming in Vietnam.

rice production is achieved without modern agricultural machinery, but economic reforms, combined with a strong work ethic have resulted in Vietnam moving from being an importer of rice during the 1980s to the world's third largest exporter of rice in the 1990s. On a more positive note, Vietnam has seen economic growth rates of around eight to nine percent annually in the past few years. Other crops such as maize, potato, sweet potato, manioc, groundnut, soybean, sugar cane, fruit trees and other perennial industry trees like coffee, rubber, tea and coconut are also important for Vietnamese agriculture.

According to the ecological and economic conditions of the country, Vietnamese agriculture can be separated into the following zones:

- The Northern Mountainous and Midland Region.
- The Red River Delta - The Northern Central Coastal Region.
- The Southern Central Coastal Region.

- The Central Highland Region - The Northeastern of South Land.
- The Mekong River Delta Region.

The majority of the rural population are farmers, 75% of them practice animal husbandry. Animal production in Vietnam represents 20-25% of total agricultural production. Only 1% of meat is exported. Livestock enterprises are very small and comprise pigs, cattle, buffalo, chickens and ducks. There are different types of livestock found in each economic zone. In the northern mountainous and middle highlands the buffalo is most widely spread, while in Central Vietnam cattle production has an advantage (47% of the country's total herd). The chicken population is distributed evenly over the entire country, while duck flocks are concentrated mainly in the Mekong Delta region (58% of total duck flocks). The animal production sector is almost wholly in the hands of smallholders (Viet Ly, 1998) (**Table 1.**).

Table 1. Distribution of pig population in the seven agro-ecological zones of Vietnam in 1995 (Viet Ly, 1998).

Agro-ecological zones of Vietnam	% of herd	% of production
1. North mountains and midlands	25.6	18.9
2. Red river delta	22.5	26.0
3. North central coast	16.4	13.0
4. South central coast	6.5	8.0
5. Central highlands	4.0	2.1
6. North east of southland	7.0	10.0
7. Mekong river delta	15.0	22.0
Total	100	100

Main animal feed resources in Vietnam

Although it has been reported that a million hectares of so-called natural pasture exist, in reality Vietnam has very limited natural pasture. With an increasing population and the establishment of new economic zones, natural pastures have been reduced to small areas mixed with crops and building constructions. In the mountainous area, hilly land is either too steep to be grazed or the soil is too poor and dry. Management of pasture has been neglected and overgrazing has created serious damage causing soil erosion. The quality of grasses in natural pastures is poor. Re-growth of grasses is not strong enough and wild weeds easily dominate it. Cultivated grasses have been studied and developed over many years in research institutes and on state farms.

Rice straw occupies a very important role in feeding ruminants. Normally, Vietnam has two rice cropping seasons per year and in some places there are three crops per year. There is about 20 million tons of rice straw produced per year. This amount is used as ruminant feed, fuel, litter and a part of it is burned in the field immediately after harvesting. An estimated 30% of rice straw is used to feed animals, which is approximately 6 million tons per year. Buffalo and cattle are fed with rice straw at night or on rainy and

cold days when they cannot graze (Viet Ly, 1998).

Rice bran is also an important feed source. It can be used for pigs and for dairy cattle but is only used as a supplement for buffalo and cattle in periods of increased work.

Maize stems gathered after harvesting are also plentiful but are rarely used as animal feed rather they are utilised as fuel. Sweet potato vines are abundant and are used mostly for pigs rather than for buffalo or cattle. There are large amounts of peanut and soybean stems available, however their harvesting period is very short and storage is difficult, therefore, very little can be utilised as animal feed and most is used as a green manure.

Sugar cane is a special industrial crop in Vietnam due to its important by-products. Molasses is a high energy feed source (for beef cattle and buffalo and also for pigs). Sugar cane is harvested in the dry season. Sugarcane top and bagasse are important forage for ruminants in areas having prolonged dry periods. Sugar cane production in Vietnam is developing quickly and its by-products will become more important in ruminant feeding in the coming years.

Although the quality of agricultural by-products is low, their huge quantity makes them important for the development of animal husbandry in Vietnam (Viet Ly, 1998).

Animal genetic resources in Vietnam

Traditionally in Vietnam, various kinds of indigenous animal genetic resources supplied a great deal of animal products to the Vietnamese people over thousands of years. The breeds were tenacious with few requirements, but in general exhibited quite low performance levels. Until 1970 many indigenous breeds were used within the extensive agricultural production system, but due to continuously changing demands, Vietnam was forced to import many kinds of high performance animal breeds and hybrids. Imported breeds were used for crossing with the Vietnamese indigenous breeds, but as of 1998 the low number of crossbred animals and animal breeds used for intensive production had had little impact when compared to local, indigenous animal breeds. For example, in 1996 there were 180 million poultry in Vietnam, of which 80% were indigenous Vietnamese breeds and 20% commercial breeds. These facts demonstrate the important role of indigenous animal breeds in Vietnam. In order to conserve indigenous animal breeds, the Vietnamese Government finances the programme 'Conservation of Animal Genetic Resources in Vietnam' (Thien, 1998). Some data, indicating the importance of local breeds are as follows:

- 80% of meat is produced by local breeds or crosses
- 75% of eggs are produced by local breeds
- 95% of farmers undertake animal production using local breeds or crosses

Breeds intended for intensive production are kept mainly around big cities (Tieu *et al.*, 2001). The various armed conflicts in which Vietnam has been involved over the past 50 years have had a highly negative influence on its economic and social development. In reality, slow economic development has resulted in the reduced exploitation of natural resources. A certain type of conservation of genetic resources was conducted until the 'Economic Reform' was introduced in 1990. Low external inputs

were associated with the use of natural resources. This meant that such types of natural resources as local breeds of animals were highly respected and used in sustainable ways. This observation can be certified in the case of several local breeds.

Vietnam is a country with abundant livestock, among which 46 local breeds are known (Viet Ly, 1998). Positive characteristics of indigenous breeds are their high level of resistance to diseases, their efficient utilization of poor quality feed, tasty meat and good adaptability to various environments. Sixteen of the local breeds are widely used in mass production, population numbers of 25 breeds are decreasing, 2 breeds are in danger (Uriu cattle, White horse), 2 breeds are in extreme danger (Rough I pig, Ri chicken) and 3 breeds have been lost (Black I pig, Son Vi pig, Van Phu chicken) (**Table 2.**). Some typical Vietnamese indigenous breeds are mentioned below.

Pig breeds

I pig (in extreme danger)

After the armed conflicts in Vietnam, a typical parameter of increasing living standards was the availability of meat to consumers. Consequently, pig production took top priority in Vietnam for the following reasons:

- 70% of domestic meat consumption is pork.
- Two thirds of manure needed by traditional farming is supplied by pigs.

In order to fulfil demands for meat, the country imported pig hybrids such as the Large White, Landrace, Duroc and Hampshire for intensive meat production. The evident increase in meat production contributed to the decrease of the I pig breed, the recent history of which paints a sad picture. Until the seventies the I pig was common and the most familiar breed to Vietnamese farmers in North Vietnam (**Figures 2 and 3**). Despite their slow growth rate, the I pig was one of the most important

Table 2. List of Vietnam livestock breeds and their status (Tieu et al., 2001).

Species	Breeds	Decreasing / Increasing	In the project	Mode for use
Cattle	Yellow	Decreasing etc		Purebred, crossed
	U Riu	Endangered	x	Purebred, crossed
	Hmong	Mass production	x	Purebred, crossed
	Phu Yen	Mass production		Purebred
Buffalo	Small	Mass production		Purebred
	Big	Mass production		Purebred
Horse	White	Endangered	x	Purebred
	Color	Increased		Purebred
Pig	Black I	Loss	x	Purebred, crossed
	Rough I	Extreme danger		Purebred
	Mong Cai	Mass production	x	Purebred, crossed
	Ba Xuyen	Decreasing	x	Purebred, crossed
	Thuoc Nhieu	Mass production		Purebred, crossed
	Nghe An Meo	Decreasing	x	Purebred
	Tay Nguyen Soc	Decreasing	x	Purebred
	Muong Khuong	Mass production	x	Purebred, crossed
	Quang Tri Mini	Decreasing	x	Purebred
	Son Vi	Loss		
Chicken	Ri	Decreasing		Purebred, crossed
	Te	Extremely Endangered	x	Purebred
	Mia	Mass production	x	Purebred, crossed
	Ho	Decreasing	x	Purebred
	Dong Tao	Increased	x	Purebred, crossed
	Tau Vang	Mass production	x	Purebred, crossed
	Dwarf	Mass production		Purebred
	Oke	Decreasing	x	Purebred
	H'Mong Brown	Decreasing	x	Purebred
	H'Mong White	Decreasing	x	Purebred
	H'Mong Black	Decreasing	x	Purebred
	Van Phu	Loss		Purebred
	Tre	Decreasing	x	Purebred
	Choi (fighting)	Decreasing		Purebred
Duck	Bau Qui	Decreasing	x	Purebred
	Bau ben	Decreasing	x	Purebred
	Co	Decreasing	x	Crossed
	Ki Lua	Decreasing	x	Purebred
	Moc	Decreasing	x	Purebred
	Trau	Decreasing	x	Purebred
Muscovy duck	De	Decreasing	x	Purebred
	Co	Decreasing	x	Purebred
Goose	Lion	Decreasing	x	Purebred
	Grey	Decreasing	x	Crossed
Rabbit	Black	Decreasing	x	Purebred, crossed
	Small	Decreasing	x	Purebred, crossed
Goat	Bach Thao	Decreasing	x	Purebred, crossed
	Phan Rang	Decreasing	x	Purebred
Sheep	Vietnam	Decreasing	x	Purebred
Pigeon				



Figure 2. I pig female.



Figure 3. I pig portrait.

breeds in traditional farming in the 1960s. The I pig was very easy for poor peasant families to keep. Not many diseases occurred in the herds, and no vaccination program had to be applied. Feeding them was easy, their diet consisting of green vegetables, grass and agricultural by-products, indeed sometimes their keepers did not feed them at all during periods of armed conflict. The I pig was a main festive dish on the tables of Vietnamese people during periods of war. Nevertheless, the I pig could not comply with the changed market and consumer requirements for less bacon and more meat in a short time in the post war period - this was the tragedy which befell the breed.

The I pig breed had two types: Black and Goc (Rough). Both were bred in Nam Dinh (Red River Delta, 100 km from Hanoi). The Black type no longer exists. The Goc type is kept in Thanh Hoa district by the project "Livestock Resources Conservation" financed by the Government of Vietnam and around 100 animals remain there.

The I pig has many characteristics that are not evident in intensive breeds. Some of these characteristics are:

- Resistance to diseases, low feed requirements, the ability to search for its own fodder on pasture.
- High fertility and prolificacy but low weight and low performance levels.
- Bacon and meat of excellent smell and taste.

The bacon of the I pig is very tasty and the percentage of fat of the slaughtered I pig is 63%. I pig stock matures early (six months), and it is for this reason that I piglets can be slaughtered and exhibit good eating qualities while piglets of other breeds are only bone and skin at that age.

During the war period, the people had only rice as a main subsistence food source, while the I pig had to forage for grass and vegetables around the house. Later, with the development of Vietnamese agriculture, I pigs could benefit from agricultural by-products other than poor grasses along harvested rice fields, and as a result their

growing parameters improved significantly (**Table 3**).

Characteristics of I pig reproduction

Their early sexual maturity is the principal advantage of the I pig. The pigs are prolific, tenacious, have few requirements, and tolerate the extreme climatic conditions of humidity and heat. The sexual maturity of I pigs occurs relatively early. Males try to jump at the age of 3-4 weeks and at 40 days of age their semen is fertile, however the best age of first reproduction is at 6 months. Females can show heat and may become pregnant at the age of four to five months; however the optimum period for their first pregnancy is after eight months of age (35-40 kg weight). Their average heat period is 19-21 days and oestrus lasts for four to five days the optimum day for service being the second day. Their gestation period is 110-115 days and litter size averages 8.8-11.3. Females are capable of reproduction until the age of 10-11 years (Viet Ly, 2001c).

Mong Cai pig (in mass production)

This breed was developed not less than 150 years ago. Thanks to a conducive seaside environment rich in sea products, Mong Cai, with its famous hanging abdomen is a pig lovers' pig breed in Vietnam. The Mong Cai breed originated in Mong Cai district, a small, pleasant district of Quang Ninh province, the most picturesque region of north-east Vietnam on the Chinese frontier bordering the famous Ha Long bay. Mong Cai pig meat is very tasty. A remarkable characteristic of this breed is its beautiful coat with three colours: black, white and pink (**Figure 4**). They are also very gentle to handle. Mong Cai pig has been common in the north of Vietnam since the 1960s and 1970s and after the war (since 1975) this breed expanded widely into central and even south Vietnam. Due to their superior parameters to those of I pig, expansion of

Mong Cai breed restricted the production area of the I pig. The Mong Cai pig, once endangered, is now playing an important role in pig production in many households practicing a semi-intensive production system. Nowadays farmers often use Mong Cai females for crossing with males of intensive foreign hybrids as Mong Cai males are considered less valuable for breeding, and this may prove dangerous for the breed in the future (Viet Ly, 2001b).

The two types of Mong Cai pigs are the heavyweight and lightweight. However spontaneous selection threatens the lightweight Mong Cai pig, which is regularly crossed with the heavyweight type. This is the reason why one generally finds the heavyweight Mong Cai in peasant homes.

The heavyweight type has a high shank, long trunk, big tubular bone, separated claw and a long muzzle with a strong build. Their adult weight is generally between 140 kg and 170 kg although sometimes up to 200 kg. Their fatty layer is formed late in the

8-9th months of age. Most of them have 14 dugs and some 12 dugs. The average litter size is 10-12 piglets.

The lightweight type of Mong Cai is of a low and thin build with a short trunk, small tubular bone, close claw and short muzzle. Its maximum weight is 85 kg. Its fatty layer is formed in around the 6th month of age. Most of them have 12 dugs and some 14 dugs. The average litter size is 8-9 piglets.

For reproductive parameters of the Mong Cai pig, also see **table 4**.

Cattle breeds

URIU cattle endangered

Uriu cattle belong to the Bovina family. The breed was naturally selected throughout the centuries for adaptation to the micro-ecology of the region of Nam Dan-Nghe An (**Figure 5**.) **Table 5** shows the standard characteristics of the breed (Viet Ly, 2001a).

Table 3. I pig weight, in kilograms, at the age of 1 to 4 years 1963 and 1994 (Viet Ly, 2001c).

Age (years)	In 1963	In 1994
1	38.4	49.4
2	44.4	58.5
3	48.4	67.7
4	49.4	73.4

Table 4. Reproductive parameters of Mong Cai pig (Viet Ly, 2001b).

Parameters	Unit	Average
Sexual activation cycle	Day	21
Heat period	Day	3-4
Sexual maturity	Month	6-8
Pregnancy period	Day	110-120
Number of litters in the year	Litter	1.5-2
Number of piglets in a litter	Piglet	10-14
Piglet weight after farrow	Kg	0.45-0.5
Piglet weight after delactation	Kg	6-7
Period between two farrows	Month	5.5-6



Figure 4. Mong Cai pig female.



Figure 5. Uriu bull.

Table 5. Some standard characteristics of adult Uriu cattle (Viet Ly, 2001a).

Withers height (cm)	Chest contour (cm)	Chest depth (cm)	Chest width (cm)	Weight (kg) female/ male	Trunk cross-length (cm)
1 134	157	56	34	210/324	122.1

Table 6. Reproductive parameters of Uriu cattle (Viet Ly, 2001a).

Parameters	Unit	Average
Age of the first sexual maturity	Months	18-20
Age of the first pregnancy	Months	22-24
Age of the first calving	Months	33-34
Period between two farrows	Months	14-32

Uriu cattle remaining in the Nghe An and Ha Tinh region number only in the tens of thousands. The shortage of water for plants especially during the dry season in the central coast of South Land causes serious problems in feed resources in Nghe An region which is endowed with poor soil and perhaps the worst climate in Vietnam. The area frequently suffers from floods and devastating typhoons (the locals say, “the typhoon was born here and comes back often to visit”). Summers are very hot and dry, while winters are cold and rainy. Temperatures vary from 6° C to 42° C and the humidity between 31% and 86%, while the average rainfall is from 1 900mm/year to 3 009 mm/year. **Table 6** shows the parameters of the breed. Traditionally Uriu cattle are raised by peasant smallholders for multipurpose use in agricultural production. Despite the Vietnamese economic growth in the last ten years, it has always been impossible to introduce vehicles or any machinery into Nghe An region, especially to Nam Dan village because its soil is gravely, infertile and full of rocks. Uriu are kept mostly for working in the fields, for transporting goods to the village, and at the end of their life for supplying meat for their keeper. Well adapted to the conditions, the Uriu is closely associated with paddy rice cultivation (**Figure 6**) and plays an important

role in the whole agriculture of Nam Dan. Uriu cattle are also considered as members of the farmer’s family not only for working their field and fertilizing their land, but also for transportation in rural areas.

The colour of the Uriu varies from yellow to brown. The male has a sickle form of a hump with which it can apply great pulling power to the yoke (U means yoke, and Riu means sickle). The female is used both for reproduction and meat production. The milk production of the female is just enough for feeding calves (**Figure 7**).

Chicken breeds

Dong Tao chicken (increasing)

The Dong Tao chicken has been saved by the demands of exigent consumers. Living in increasingly good economic conditions, some Vietnamese people are returning to their old traditions looking for different exotic dishes. The Dong Tao chicken is an indigenous breed, originated from Hai Hung Province (Hung Yen - Red River Delta). They are red with variants (90%) or yellow (10%) coloured plumage with no special pattern on the feathers (4). They have yellow skin, shanks and feet. The comb may be of pea (90%) or single (10%) type and eggshells are



Figure 6. Uriu bull in every day work as a drawing power.



Figure 7. Uriu cow and calf.



Figure 8. Dong Tao chicken (male).

brown in colour. They have very big shanks and a large skeleton (**Figures 8 and 9**). Adult males weigh on average 3.6 kg, and females 2.6 kg. Dong Tao chicken are very popular in the district of Dong Tao villages. The breed shows rapid growth, and produces tasty eggs and meat.

The reproductive parameters of Dong Tao chicken were estimated in a trial (Nga *et al.*, 1999) as follows:

- In a 36-week egg production period, average egg production was 68 eggs per hen with a feed consumption of 4.1 kg per 10 eggs.
- The average weight of eggs was 45.3 g at the chicken's age of 38 weeks. Egg fertility was estimated as 89%.
- Hatchability was 70.1% compared to the total hatching eggs.
- The Dong Tao chicken is famous for its very big shank.

The most valuable dishes in the Vietnamese and Chinese kitchen are duck tongue and chicken shank. With its particularly big shank Dong Tao chicken meets the gourmet tastes of Vietnamese people. The breed might have been selected centuries ago especially for the size of its shank, to raise the yield of that table delicacy. Due to the conservation program supervised by the National Institute of Animal Husbandry, Dong Tao chicken spreading in many households around Hai Duong. It is hoped that by virtue of its famous taste Dong Tao chicken will be saved.

Duck breeds

Bau Qui duck (decreasing)

Many years ago, Vietnam created two distinct duck types, one for egg and one for meat production. The Bau Qui duck is considered a meat duck in traditional farming (**Figure 10**). Their origin is Quy Chau village in the highlands of Nghe An region, 150 km from Vinh, the central town of Nghe An. Quy Chau and its surrounds are isolated from civilisation. Inhabited by the Thai ethnic group, small villages are girt by wonderful mountains and streams (**Figure 11**). A long-standing tradition of Quy Chau's Thai ethnic group is to kill all animals different from their indigenous breeds, those coming from other parts of the mountains. People believe that foreign animals bring in bad luck for their own flocks. Due to this



Figure 9. Dong Tao chicken (female).

Thai tradition, purebred Bau Qui duck can still be found in that region (**Table 7**).

Bau Qui ducks are very clever at finding their natural feed which consists mainly of fish and insects, and which they can obtain from paddy fields, streams or forests. Sometimes they get rice, corn and by-products from kitchens and fields. They are highly adapted to the hot environment and have high survival ability. Their meat is delicious and valuable due to the high essential amino acid content (Chuyen *et al.*, 2001). Like any other local poultry the breed is threatened, as they can easily disappear due to their low production levels and crossing with other intensive ducks, which were introduced into this region in the 1990s.

Governmental activities to conserve animal genetic resources

To protect animal genetic resources, the Vietnamese government is supporting different genetic conservation activities. The National Institute of Animal Husbandry (NIAH) is the leading institute managing the conservation activities of AnGR. The institute consists of ten research departments and a series of research centres, with different

Table 7. Reproductive parameters of Bau qui duck (Chuyen *et al.*, 2001).

Parameters	Unit	Average
Age of the first egg-laying	Days	190-210
Weight at the first egg-laying	kg	1.6-1.9
Age of the first mating of the male	Days	180-200
Weight of male at the first mating	kg	1.8-2.0
Egg laying period per year	Days	132
Eggs number per year	Eggs	80,8
Eggs fertility	%	97.2-98.19
Hatchability by brooding	%	90.9-92.7
Hatchability by artificial incubation	%	93.5-94.5
Mortality at the age of 25 th day	%	4.6
Mortality at the age of 70 th day	%	4.8
Body weight at the 60 th day age (free range and self-feeding)	g	1 055
Body weight at the 120 th day age (free range and self-feeding)	g	1 920



Figure 10. Bau Qui ducks.



Figure 11. Bau Qui habitats.

breeding and research objectives in pig, cattle, buffalo, horse, goat, rabbit, chicken, duck and even deer and ostrich production. Concerning AnGR in Vietnam, NIAH is responsible for:

- Distributing animals throughout their original habitats, providing financial and technical support for organizations and households managing the animal husbandry.

- Keeping animals at universities and research institutions for the purpose of examining their physiology and reproduction parameters.
- Increasing the size of breeds having market potential.
- Cooperating with other projects inside and outside Vietnam to establish step by step conservation systems for genetic materials.
- Establishing biodiversity information systems and publishing documents (Viet Ly *et al.*, 2000, Thien, 1998).

Besides the breeding and research activities of NIAH, there are several governmental institutions involved in the management of AnGR. The National Institute of Veterinary Medicine is responsible for animal health studies in the country. Universities are taking part in animal research through their faculties such as the Animal Production and Veterinary Faculties of Hanoi Agricultural University, the University of Agriculture and Forestry at Hue, Nong Lam University at Thu Duc near Ho Chi Minh City, Can Tho University, the University of Agriculture and Forestry at Thai Nguyen, the universities at Thanh Hoa and Vinh and others. These universities belong to the Ministry of Education and Training. At ministry level there is a Committee of Science on Animal Research, which is responsible for regulating and formulating research projects in the country and also evaluating experimental results. Every year, some appropriate technological advances are identified and transferred to production through a network of support services.

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Population viability analysis of the Uruguayan Creole cattle genetic reserve

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Summary

Uruguayan Creole cattle are descended from animals brought by the Spanish conquerors. The population grew extensively without directional management and became semi-wild before the introduction of commercial breeds in the 19th century. Today only 575 animals remain, restricted to the San Miguel National Park. We performed a population viability analysis of this reserve using VORTEX v. 8.31 to study its demographic and genetic parameters, assess the environmental factors that affect its development, evaluate its future risk of extinction and test different management options. The probability of extinction in the next 100 years was always zero, even in the more pessimistic scenarios. The growth rate of the population was always positive and mostly affected by the mortality rate of calves. Population size increased rapidly up to carrying capacity, this being the only limiting factor for population growth. Retained heterozygosity was always above 90% and the inbreeding coefficient below 0.10. The analysis shows that the population is not at risk due to its genetic diversity and demographic structure, however all the individuals are concentrated in only one place. We suggest its subdivision into sub-populations located in different regions and connected by gene flow, decreasing the risk of extinction and accomplishing the conservation and self-sustainability goals.

Resumen

La raza vacuna Criolla uruguaya descende de los animales traídos por los conquistadores españoles. La población creció de forma extensiva sin ningún tipo de gestión y se convirtió en semi-salvaje antes de la llegada de las razas comerciales en el siglo XIX. Hoy en día sólo quedan 575 animales, principalmente concentrados en la región del Parque Nacional de San Miguel. Se realizó un análisis de viabilidad de la población en esta reserva utilizando VORTEX v.8,31 para estudiar sus parámetros demográficos y genéticos, controlar los factores ambientales que afectan su desarrollo, evaluar los riesgos futuros de extinción y probar distintas formas de gestión. La probabilidad de extinción en los próximos 100 años fue cercana a cero, incluso considerando las opciones más pesimistas. La media de crecimiento de la población fue siempre positiva y mayormente se vio afectada por la media de mortalidad de las terneras. El incremento rápido de la población para desarrollar su capacidad fue el único factor limitante para el crecimiento poblacional. La heterocigosis fue siempre por encima del 90% y el coeficiente de consanguinidad por debajo de 0,10. El análisis mostró que la población no se encuentra en peligro gracias a su diversidad genética y a la estructura demográfica, sin embargo, todos los individuos están concentrados en un único lugar. Sugerimos subdividir las subpoblaciones localizadas en distintas regiones y conectarlas por un flujo de genes,

para de esta manera disminuir el riesgo de extinción y llevar a cabo un programa de conservación con objetivos de auto sostenibilidad.

Keywords: *Population viability analysis, Uruguayan Creole cattle, modelling, Carrying capacity of the environment, Population Viability Analysis (PVA).*

Introduction

Local cattle populations have a very valuable genetic potential for sustainable agriculture, as they represent the consequence of local adaptation processes. Unlike commercial breeds, strongly selected for production purposes, local breeds have evolved mostly as a result of natural selection for centuries, becoming a very interesting source of genetic variation. They are a key factor for promoting sustainable development together with environmental preservation (Cardellino, 2002; derived from FAO, 1998).

In Latin America many animal genetic resources are at risk, mainly due to the process of genetic introgression from commercial breeds (Medrano, 2000). Most local breeds persist as small, scattered populations. Small populations are unstable, as they are more exposed to the random fluctuations of factors that can lead to extinction, such as demographic stochasticity, environmental variation, catastrophes, genetic drift and inbreeding depression. The combination of these random forces destabilizes small populations, in a feedback process called the “extinction vortex” (Ballou, 1993; Lacy and Clark, 1993).

Several approaches can be used to assess the risk of extinction of small populations, Population Viability Analysis (PVA) being the most widely applied. PVAs are computer models that allow population managers to simulate the dynamics of the extinction process, estimate the effects of the interacting random factors and assess the long-term viability of small populations. They provide quantitative predictions for population

growth, demographic fluctuations and genetic variation, based on different assumptions. PVAs are also useful for testing the adequacy of alternative management options (Lindenmayer *et al.*, 1993; Lacy and Clark, 1993). Several PVA packages have been proposed (Brook *et al.*, 1999).

As an example of American Creole cattle, the Uruguayan Creole descends from the cattle brought by the Spanish conquerors after their discovery of Uruguay in 1492. The first bovines were introduced to what is now Uruguay between 1611 and 1620, from the Iberian Peninsula and the Jesuit Missions of Alto Uruguay (Primo, 1992). The extremely good environmental conditions for these animals favoured their multiplication in the region. The cattle population grew extensively, without directional management and became semi-wild. Late in the 19th century, the introduction of more selected European breeds caused the decline of the Creole cattle (Giovambattista *et al.*, 2001).

After 400 years of natural selection, Uruguayan Creole cattle (UCC) are considered to be adapted to the environment of the country. Even considering the possibility of some genetic introgression from commercial breeds, it is assumed that they have remained mostly in reproductive isolation, as their phenotype is clearly similar to other American Creole cattle and to certain Spanish ancient breeds considered ancestral (Postiglioni *et al.*, 1998; Rincón *et al.*, 2000; Rodríguez *et al.*, 2001). Today there are only around 600 animals restricted to San Miguel National Park, in the department of Rocha in the south-east of Uruguay. This reserve originated from a foundation stock of 35 individuals that were brought from inhabited regions of the country in around 1930 (Arredondo, 1958). These animals were the remnants of the original huge population that spread over all the country, and had lived under natural, unmanaged conditions until that moment.

The reserve consists of 25 bulls, 445 cows and 105 calves of both sexes, in an area of 600 hectares of wetlands, prairies, native woods and ridges. Directional management

of the population is minimal, consisting only of the periodic extraction of a certain number of males as a way of controlling population size. Mating occurs in natural conditions and the reserve has never been subject to any kind of artificial selection.

The objective of this study was to perform a population viability analysis of the present San Miguel Creole cattle reserve, to study its demographic and genetic parameters and to assess the environmental factors that may affect its development. We also evaluated the risk of extinction and test different management options.

Materials and Methods

The complex interactions between demographic, environmental and genetic factors in the UCC population were examined by computer simulation modelling using the program VORTEX, version 8.31. The structure, algorithms and assumptions of the program are outlined in Lacy (1993). VORTEX is a population viability assessment program for modelling population dynamics. It allows for the variation of levels of different parameters and management options, and estimates their effects on the population, this being an aid to conservation goals. The model has been widely used in several species and is especially powerful for modelling vertebrate wildlife population behaviour (Lacy, 1993; Lacy and Clark, 1993). This is the first time this program will be used to analyze the dynamics of a semi-wild population of a domestic species.

The program yields the following information:

- The probability of persistence of the population: for a maximum population size (Nmax) the expected persistence time will depend on the average growth rate r ($r = \text{no. births} - \text{no. deaths}$) as well as the variance of this parameter due to environmental fluctuations.
 - The size of the average population along the time scope considered.
 - The expected and observed retained average heterozygosity after the time scope considered.
- VORTEX simulates the transmission of alleles from parents to offspring at a hypothetical neutral (non-selected) genetic locus, and so models the loss of genetic diversity. At the beginning of the simulation each animal is assigned two unique alleles for that locus, and each offspring created during the simulation is assigned one of the alleles from each parent at random. VORTEX assesses how many of the original alleles remain in the population, and the average heterozygosity (gene diversity) relative to the starting levels (Lacy, 1993). VORTEX can indicate the average number of alleles, the final allele composition of the population, the growth rate (stochastic and deterministic r) and the probability of extinction: in VORTEX extinction is defined as the absence of any of the sexes.
- The variables introduced were:
- The size of the initial population: two basic scenarios were performed considering two initial population sizes, one with the present population size of 575 animals, and another one with an alternative smaller population size of 400 tested as a management option. Age and sex distribution were the same as in the present real population, derived from the census data of the year 2002 (Table 1). For the 400 individual population, age and sex classes were calculated in proportion to the real distribution. During simulations VORTEX distributed the age-sex structure according to the reproduction and death rates specified in each scenario, using the deterministic algorithms of Leslie's matrix.
 - The number of iterations and years (time scope): every scenario was repeated 100 times and for 100 years. Results were summarized every ten years.
 - The carrying capacity of the environment (K): two basic scenarios were considered, one with a K of 600 (s.d. 50) individuals, similar to the real estimate for an area of 600 hectares in this geographical region,

Table 1. Age and sex distribution of the UCC founder (c. 1930) and present (2002) populations.

Age and sex class	Founder population (N = 35)	Present population (N = 575)
Females 0 -1 years	4	50
Females 1 – 2 years	-	90
Females 2 – 3 years	-	125
Females 3 years or more	25	230
Males 0 – 2 years	4	55
Males 2 years or more	2	25

and another one of 1 000 (s.d. 80) individuals, to test the growth potential of the population. VORTEX fixes carrying capacity as an upper limit for population size, beyond which an additional mortality rate is imposed, proportional along all age-sex classes in order to return the population to the specified K value.

- Migration and supplementation: these were not considered, as this is the only known UCC population.
- The mating system: the breeding system modelled by VORTEX assumes that mates are randomly reshuffled each year and that all animals that can breed have an equal probability of breeding. It is possible to choose between monogamous mating, where there must be a male for each female, or polygamous mating, where there needs to be at least one breeding male for all breeding females. The UCC has polygamous mating.
- The age of reproductive maturity of females: one year (not considering gestation period). The age of reproductive maturity of males is two years.
- The maximum breeding age (senescence): nine years, for both sexes.
- The sex ratio at birth: 50%.
- The average litter size: one.
- The proportion of adult females and males in the breeding pool: the proportion of breeding females per year is 55% (s.d.: 10%). Three different scenarios were studied according to a proportion of breeding males of 15%, 30% and 50%, 15% being the approximate present value

and 50% an ideal natural scenario. The value of 30% is an intermediate alternative management option.

- Inbreeding depression: we have not detected in the population the effects of inbreeding depression, as the estimated values for inbreeding based on recent studies of this reserve with molecular markers show a very low inbreeding coefficient of between 0.020 and 0.038 (Postiglioni *et al.*, 1998; Armstrong, 2004).

However, we wanted to test if inbreeding could be a future problem. In VORTEX inbreeding depression is modelled as a loss of viability of inbred animals during their first year. The severity of inbreeding depression is measured by the number of “lethal equivalents”, this being an estimate of the average number of lethal alleles per individual in the population if all deleterious effects of inbreeding were caused only by recessive lethal alleles (Lacy, 1993). In this case we assumed that the studied species responded to inbreeding in a similar way to the average (3.14 lethal equivalents per diploid genome) reported in the survey of 40 ungulate mammal species by Ralls *et al.* (1988).

- Reproduction and survival: as these cattle live in a natural environment, survival and reproduction are related. Being a domestic species subjected to certain management practices, reproduction does not depend on population density but only on the carrying capacity of the environment.
- Mortality: mortality can be introduced into VORTEX in four different ways:

- a) as the annual expected mortality rate for each age-sex class, with its corresponding standard deviation;
- b) as a fixed number of harvesting (extractions) of animals for each age-sex class;
- c) as a catastrophic event that reduces the normal survival rate to a fixed amount; and
- d) when K is exceeded all age-sex classes are proportionally reduced, as was said before.
- Three different scenarios for the annual mortality rate of individuals under one year of age (calves of both sexes) were considered: 10% (s.d. = 3%) similar to the current estimations, 25% (s.d.=5%) as an intermediate value, and 40% (s.d.=5%) as a maximum value related to environmental conditions, the first year of life being most critical in large mammals. The annual mortality rate of animals above one year of age is 3% (s.d.=0.8%).

The harvesting of males was also considered, as this is a current practice in the reserve. Three different possibilities were explored in the analysis: 0 (no harvesting), 25 and 50 animals per year. Today around 50 young bulls of one year of age are harvested every year, as a way of controlling the population size.

Catastrophes are events that affect the population beyond the normal parameters of environmental variation, defined by VORTEX as an increase in adult mortality. They can affect reproduction, survival or both. Examples are severe food shortage, floods, fires, droughts or epidemics. Catastrophic events are introduced with a probability of occurrence and a severity factor of between 0.0 (maximum effect) and 1.0 (no effect). We considered a probability of 5% per year (one every 20 years), affecting the reproduction of 50% of the animals and the survival of 20% (0.5 and 0.2 severity factor, respectively).

In order to analyze how this reserve could have developed, two simulations were performed taking into account the foundation population from which this

reserve originated. It consisted of 35 individuals, of known sex and age according to historical data from Arredondo (1958) (Table 1). The simulations were performed for a time scope of 70 years (1930-2000) under similar conditions to those naturally experienced by for cattle species (50% of reproductive males, 65% of reproductive females and 25% of annual mortality rate of individuals under one year of age). The other parameters were observed in the same way as in the previously cited simulations. The only variable parameter introduced in this case is male harvesting (as it is not known how the population was managed in this respect) using one scenario with no harvesting and another with the harvesting of 40 males per year starting from the tenth year.

In the present and foundation populations there is a clear predominance of reproductive females above three years of age. The ratio of males and females has been maintained relatively constantly throughout the history of the population. In the present reserve, males represent 14% of the total population, and constituted 17% of the foundation population. With reference only to the reproductive males, they represent 6.6% of the current population represented 7.4% of the foundation population.

Results. Population Viability Analysis (PVA)

The results of the Population Viability Analysis (PVA) are shown in the Appendix. In total, 100 simulations of 83 different scenarios were performed. The probability of extinction of the population in 100 years was always zero, even in the more pessimistic scenarios with a mortality rate of individuals under one year of age of 40%, only 15% of males in the breeding pool and the harvest of 50 males per year.

In all cases the population size increased rapidly until maximum carrying capacity is reached, in less than ten years (Figure 1). The

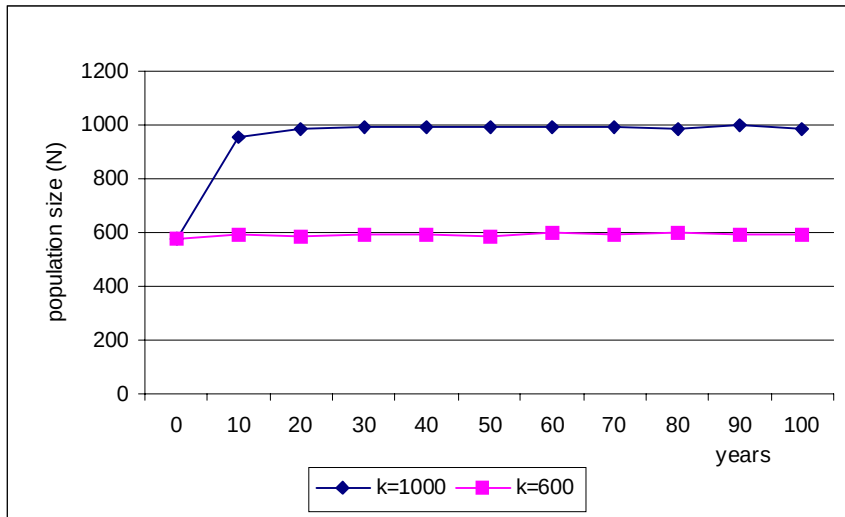


Figure 1. Population size vs. time, according to carrying capacity and for the next 100 years, taking as start point scenario the present one (population of 575 animals, 10% mortality rate of calves, 15% of reproductive males and harvest of 50 males per year).

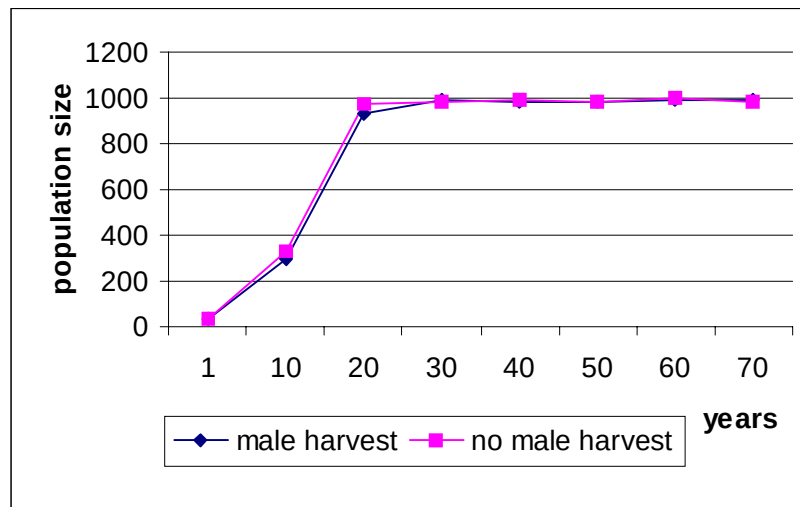


Figure 2. Population size vs. time for different male harvest strategies, taking as start point scenario the founder population of 35 individuals (Arredondo, 1958).

same happens when the growth of the foundation population of 35 individuals is simulated (Figure 2). According to this, the carrying capacity would be the only limiting factor for population growth. Today it can be observed that the population is in constant growth, the annual harvest of males being

the only means to avoid exceeding the carrying capacity of the area designated for the reserve.

In our analysis the observed growth rate (r) of the population was always positive, and was mostly affected by the mortality rate of individuals under one year of age, decreasing as this rate increased (Figure 3).

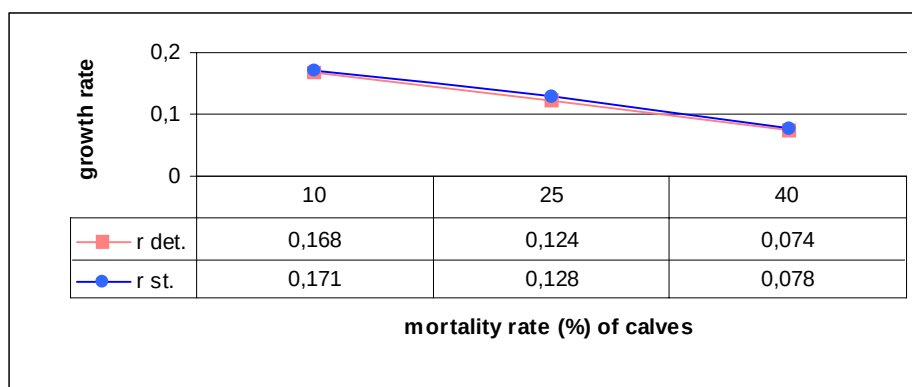


Figure 3. Growth rate (r) vs. mortality rate of calves. The start point scenario is the present population, with 15% of reproductive males and harvest of 50 males per year. r det.: deterministic r ; r st: stochastic r .

The values of retained genetic diversity were very high, even in the most pessimistic scenarios, which is a key factor for conservation strategies. Remaining heterozygosity was always above 90% and the inbreeding coefficient was below 0.10. This shows that the age-sex distribution of the population allows for adequate levels of genetic diversity to be maintained along time.

The proportion of reproductive males did not affect the predicted level of genetic diversity retained after 100 years. Although an increase in the retained heterozygosity and a decrease in the inbreeding coefficient could be observed as the proportion of reproductive males increased, these differences were not relevant (Table 2). The harvest of males had even less effect on this parameter.

These results clearly show that the population is able to survive and develop with the current age-sex classes and genetic

diversity, and that it is most significantly subject to geographic area availability.

Discussion

The analysis performed with VORTEX clearly showed that the population is not at risk due to intrinsic factors, such as genetic diversity and demographic structure. Very high predicted levels of retained heterozygosity could be observed after 100 years of simulations, without a significant increase in inbreeding. According to Ballou (1993), a management program that predicts a probability of 95% of population survival and a 90% of retained genetic diversity for the next 100 years can be considered successful.

Several studies with molecular markers of the UCC population, including the analysis of 18 microsatellites, revealed high levels of

Table 2. Levels of inbreeding and of retained heterozygosity for the next 100 years for different percentages of reproductive males. The start point scenario is the present population (575 animals, carrying capacity: 600, 10% of mortality of calves and harvest of 50 males per year).

% of males	F	He
15	0.067	0.9311
30	0.052	0.9476
50	0.039	0.9570



Figure 4. A herd of Uruguayan Creole cattle.



Figure 5. Example of genetic diversity in a herd of Uruguayan Creole cattle.

observed heterozygosity (>0.50) and low levels of inbreeding (<0.05) (Rincón *et al.*, 2000; Postiglioni *et al.*, 2002; Armstrong, 2004; Armstrong *et al.*, 2005). All these findings suggest that the demographic structure of the population is stable and able to maintain good levels of genetic diversity through time, given the current management strategies (Figure 4 and 5).

The parameters obtained showed that the population is safe from the genetic and demographic factors for the next 100 years. In all the simulations we obtained positive values of r , which shows that the population has a very high intrinsic growth potential. The clear predominance of reproductive females above three years of age, in the present and in the foundation populations, must have favoured the development of the population at the outset as well as in its current growth. The carrying capacity of the environment is the only limiting factor. It is clear that the reserve could grow and develop without reaching risky inbreeding levels if it had better opportunities for expansion. This could be achieved, for example, by increasing the available geographical area.

According to Lacy (1993) and Foose (1993), in order to minimize the consequences of genetic drift and founder effect, small managed populations should start with a number of founders not less than 20 and reach the carrying capacity of the environment as soon as possible. It is estimated that 20 founders would carry approximately 97.5% of the genetic variability present in the ancestral population and the rate of genetic diversity loss would be 2.5% per generation as the population grew. A final effective population size (N_e) of 100 individuals would serve to retain at least 90% of its genetic diversity. So, the carrying capacity of the environment should be significantly larger than the N_e if this objective is to be accomplished. In the case of the UCC reserve, which is descended from 35 founder animals, population development has been rapid. Today the reserve consists of 575 individuals, the N_e

estimated is 87, and the carrying capacity of the area is estimated at 600 animals. These data show that the population is in an acceptable situation for the conservation of its genetic diversity, but an increase in size and carrying capacity of the environment would be better for its continued development.

The mortality of animals of less than one year of age is the internal factor that affects the population growth most noticeably. It is important however, to maintain low rates of calf mortality if a rapid expansion of the population is required for management reasons. According to field data from the last two years, the actual rate is around 10%. In the present analysis it is showed that this percentage is adequate for maintaining a high population growth rate.

According to the predictions of the simulations, the proportion of breeding males and the harvest of males do not have an important effect on population growth or on the genetic diversity levels retained. This means that the reserve could be maintained with the current percentage of only 15% of males in the breeding pool, which makes management easier. In the case of an annual rotation of males being performed, high levels of genetic diversity would be maintained, but the subsequent increase in heterozygotic frequency would alter the genetic parameters of the population. On the other hand, the low proportion of breeding males in comparison to the females diminishes significantly the N_e and can cause a bottleneck effect (Hartl, 1988; Kantanen *et al.*, 2000).

The risk degree of a breed depends on many factors. According to FAO (derived from FAO, 1998) and Ponzoni (1997), the UCC can be considered as threatened, taking into account the relative number of breeding males and females. However, there are other criteria for the evaluation of the risk level of a breed or population that take into account levels of genetic diversity, demographic indexes, geographical localization of the populations, number of founders, etc. (da Gama, 2002; Lacy, 1993).

In the present situation, the UCC is not at risk in relation to its genetic and demographic parameters. However, the fact that all the Uruguayan Creole cattle are concentrated in only one location places the reserve in a potentially hazardous situation. If the population suffered from extreme local conditions or catastrophe, such as a severe draught, flood or some infectious disease, that led the population to a critical minimum number, it might not be able to recover and the UCC could disappear completely.

Management implications

The PVA allowed us to identify and quantify the actual trends in the population under the present circumstances. Modelling population dynamics provides a prediction of the likely behaviour of populations in response to selected parameters, and is also useful in determining key management measures.

Further use of PVA to test different possible scenarios could help to develop other management measures, for example, the regulation of population size by means of harvesting both males and females in order to assure the viability and maintenance of an adequate N_e and genetic variability.

We suggest an alternative management strategy to lower the potential risk of concentrating the population in a unique geographical area, applying a metapopulation model (Ballou, 1993; Lacy, 1993). The present population has enough levels of genetic diversity and potential growth to allow its subdivision into many sub-populations without putting at risk the future of the breed. This is an important advantage in conservation as it allows for better planning and more effective management (Lacy and Clark, 1993; Lindenmayer *et al.*, 1993).

These sub-populations would be located in different regions of the country, avoiding the risk of extinction associated with a given local extreme circumstance. When the management option allowed it, they would be connected by gene flow, by the exchange

of breeding individuals. This system favours the maintenance of high allelic diversity and increases considerably the effective population size. High rates of migration contribute to the stability of the sub-populations and reduce the risk of extinction (Ballou, 1993; Lacy, 1993).

This model would allow for the maintenance of genetic reserves in San Miguel National Park and in other natural areas and for the evaluation of productive parameters in the natural environment without any artificial selection (*in-situ* conservation). We also propose the creation of other sub-populations with different environmental and management situations, including some kind of artificial selection in order to evaluate the productivity and viability of the UCC for its sustainable use.

The implementation of a more accurate system of individual identification and a pedigree register of the population would be of invaluable aid for its management. A germplasm bank of semen and embryos is also important for the conservation of the breed, as it allows for a wider scope of future management options.

In this way, the extinction risk of the UCC would be decreased, accomplishing the conservation and self-sustainability goals.

Acknowledgement

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Appendix

Population viability analysis for the 83 scenarios. Scenario (Sc.), % mortality of individuals of less than 1 year of age (mort 0-1), % of males in the breeding pool (% males), number of males harvested per year (male harv.), deterministic r (det r), stochastic r (st. r), proportion of retained observed (H_o) and expected (H_e) heterozygosity after the time scope considered, inbreeding coefficient attained after the time scope considered (F) and probability of extinction of the population (Ext. P).

Initial population size: 400, carrying capacity: 600.

Sc.	Mort 0-1	% males	Male harv.	Det. r	St. r	H_o	H_e	F	Ext. P
1	10	15	50	0.168	0.1710	0.9415	0.9386	0.059	0
2	25	15	50	0.124	0.1281	0.9425	0.9406	0.058	0
3	40	15	50	0.074	0.0783	0.9432	0.9406	0.057	0
4	10	30	50	0.168	0.1712	0.9563	0.9525	0.043	0
5	25	30	50	0.124	0.1286	0.9547	0.9546	0.045	0
6	40	30	50	0.074	0.0789	0.9590	0.9552	0.041	0
7	10	50	50	0.168	0.1712	0.9586	0.9578	0.041	0
8	25	50	50	0.124	0.1278	0.9619	0.9597	0.038	0
9	40	50	50	0.074	0.0777	0.9625	0.9606	0.038	0
10	10	15	25	0.168	0.1730	0.9417	0.9399	0.058	0
11	25	15	25	0.124	0.1286	0.9472	0.9429	0.053	0
12	40	15	25	0.074	0.0800	0.9518	0.9509	0.048	0
13	10	30	25	0.168	0.1727	0.9588	0.9559	0.041	0
14	25	30	25	0.124	0.1287	0.9606	0.9574	0.039	0
15	40	30	25	0.074	0.0795	0.9635	0.9601	0.037	0
16	10	50	25	0.168	0.1712	0.9638	0.9612	0.036	0
17	25	50	25	0.124	0.1287	0.9651	0.9636	0.035	0
18	40	50	25	0.074	0.0796	0.9674	0.9642	0.033	0
19	10	15	0	0.168	0.1741	0.9477	0.9451	0.052	0
20	25	15	0	0.124	0.1305	0.9496	0.9467	0.050	0
21	40	15	0	0.074	0.0819	0.9565	0.9526	0.044	0
22	10	30	0	0.168	0.1738	0.9596	0.9567	0.040	0
23	25	30	0	0.124	0.1303	0.9638	0.9611	0.036	0
24	40	30	0	0.074	0.0803	0.9640	0.962.	0.036	0
25	10	50	0	0.168	0.1735	0.9636	0.9621	0.037	0
26	25	50	0	0.124	0.1299	0.9669	0.9647	0.033	0
27	40	50	0	0.074	0.0806	0.9689	0.9664	0.031	0

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Initial population size: 575, carrying capacity: 600.

Sc.	Mort 0-1	% males	Male harv.	Det. r	St. r	Ho	He	F	Ext. P
28	10	15	50	0.168	0.1706	0.9331	0.9311	0.067	0
29	25	15	50	0.124	0.1264	0.9357	0.9321	0.064	0
30	40	15	50	0.074	0.0770	0.9320	0.9285	0.068	0
31	10	30	50	0.168	0.1711	0.9485	0.9476	0.052	0
32	25	30	50	0.124	0.1265	0.9519	0.9491	0.048	0
33	40	30	50	0.074	0.0764	0.9487	0.9451	0.051	0
34	10	50	50	0.168	0.1716	0.9597	0.9570	0.039	0
35	25	50	50	0.124	0.1266	0.9575	0.9563	0.043	0
36	40	50	50	0.074	0.0772	0.9542	0.9518	0.046	0
37	10	15	25	0.168	0.1726	0.9440	0.9407	0.056	0
38	25	15	25	0.124	0.1274	0.9460	0.9426	0.054	0
39	40	15	25	0.074	0.0792	0.9499	0.9469	0.050	0
40	10	30	25	0.168	0.1723	0.9578	0.9547	0.042	0
41	25	30	25	0.124	0.1300	0.9603	0.9572	0.040	0
42	40	30	25	0.074	0.0780	0.9610	0.9581	0.039	0
43	10	50	25	0.168	0.1724	0.9646	0.9618	0.035	0
44	25	50	25	0.124	0.1280	0.9652	0.9624	0.035	0
45	40	50	25	0.074	0.0795	0.9668	0.9642	0.034	0
46	10	15	0	0.168	0.1729	0.9486	0.9465	0.051	0
47	25	15	0	0.124	0.1295	0.9521	0.9501	0.048	0
48	40	15	0	0.074	0.0821	0.9587	0.9552	0.041	0
49	10	30	0	0.168	0.1737	0.9619	0.9581	0.038	0
50	25	30	0	0.124	0.1316	0.9625	0.9599	0.038	0
51	40	30	0	0.074	0.0812	0.9676	0.9638	0.033	0
52	10	50	0	0.168	0.1753	0.9640	0.9625	0.036	0
53	25	50	0	0.124	0.1308	0.9662	0.9653	0.034	0
54	40	50	0	0.074	0.0814	0.9694	0.9672	0.030	0

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Initial population size: 575, carrying capacity: 1000.

Sc.	Mort 0-1	% males	Male harv.	Det. r	St. r	Ho	He	F	Ext. P
55	10	15	50	0.168	0.1714	0.964	0.9623	0.036	0
56	25	15	50	0.124	0.1287	0.9648	0.9634	0.035	0
57	40	15	50	0.074	0.0790	0.9681	0.9654	0.032	0
58	10	30	50	0.168	0.1716	0.9736	0.9718	0.026	0
59	25	30	50	0.124	0.1282	0.9755	0.9732	0.024	0
60	40	30	50	0.074	0.0785	0.9755	0.9742	0.024	0
61	10	50	50	0.168	0.1722	0.9765	0.9753	0.023	0
62	25	50	50	0.124	0.1288	0.9774	0.9768	0.022	0
63	40	50	50	0.074	0.0783	0.9789	0.9768	0.021	0
64	10	15	25	0.168	0.1726	0.9651	0.9632	0.035	0
65	25	15	25	0.124	0.1298	0.9689	0.9663	0.031	0
66	40	15	25	0.074	0.0802	0.9682	0.9684	0.031	0
67	10	30	25	0.168	0.1731	0.9742	0.9731	0.026	0
68	25	30	25	0.124	0.1292	0.9761	0.9744	0.024	0
69	40	30	25	0.074	0.0809	0.9774	0.9758	0.022	0
70	10	50	25	0.168	0.1728	0.9786	0.9767	0.021	0
71	25	50	25	0.124	0.1291	0.9792	0.9775	0.020	0
72	40	50	25	0.074	0.0808	0.9806	0.9787	0.019	0
73	10	15	0	0.168	0.1737	0.9683	0.9655	0.032	0
74	25	15	0	0.124	0.1298	0.9686	0.9677	0.032	0
75	40	15	0	0.074	0.0819	0.9716	0.9703	0.029	0
76	10	30	0	0.168	0.1748	0.9750	0.9738	0.025	0
77	25	30	0	0.124	0.1310	0.9771	0.9754	0.023	0
78	40	30	0	0.074	0.0820	0.9790	0.9769	0.021	0
79	10	50	0	0.168	0.1737	0.9797	0.9778	0.020	0
80	25	50	0	0.124	0.1303	0.9798	0.9783	0.019	0
81	40	50	0	0.074	0.0817	0.9808	0.9793	0.019	0

Founder population. Population size: 35, carrying capacity: 1000.

Sc.	Mort 0-1	% males	Male harv.	Det. r	St. r	Ho	He	F	Ext. P
82	25	50	40	0.165	0.1705	0.9400	0.9393	0.060	0
83	25	50	0	0.165	0.1730	0.9443	0.9427	0.056	0

Evaluación de la variabilidad genética en ganado Criollo Colombiano mediante 12 marcadores microsatélites

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Resumen

El objetivo del presente trabajo fue estimar la variabilidad y las relaciones filogenéticas entre 6 razas de ganado criollo colombiano, cebú Brahman y la española Pirenaica, mediante el uso de 12 marcadores moleculares tipo microsatélite. El número promedio de alelos fue de 11.58 con los valores más altos para los marcadores HEL 13 y ETH 10. La heterocigocidad promedio de todas las razas fue de 0.7 y el coeficiente de endogamia fue de 0.097, con los valores más altos para la raza Romosinuano. Los mayores valores de diversidad se presentaron en la raza Casanareño. La distancia genética entre las razas criollas colombianas y la raza española Pirenaica fue amplia (0.7-1.7) indicando posiblemente poca intervención de esta raza en el origen de las razas criollas. En general, las mayores distancias genéticas se presentaron entre las razas de origen *Bos taurus* (razas criollas colombianas y Pirenaica) con respecto a la *Bos indicus* (Brahman).

Summary

The present study was carried out with the aim of assessing the genetic diversity and estimating the phylogenetic relationships between six of the Creole Colombian cattle breeds and the Zebu Brahman breed, using a panel of 12 microsatellites and the sequencing of the D-Loop fragment from the mitochondrial DNA. The average allele

number was 11.58 with the highest values for the HEL13 and ETH10 microsatellites. The mean heterozygosity was 0.7 and the coefficient of inbreeding was 0.097, with the highest values for the Romosinuano breed. Similarly, the largest values for diversity appeared in the Casanareño breed, using the two approaches. The resulting haplotypes from the D-Loop fragment within the Creole breeds and in the Zebu Brahman were predominantly *Bos taurus* of European origin, which suggests a taurine maternal origin for these breeds.

Palabras clave: Diversidad genética, Ganado bovino, Microsatélites, Raza Casanareño, Raza Romosinuano, Raza Costeño con Cuernos, Raza Blanco Orejinegro, Raza San Martinero, Raza Hartón del Valle.

Introducción

Colombia posee 7 razas reconocidas de ganado criollo: Romosinuano (Romo) y Costeño con Cuernos (CCC) en la Costa Atlántica, Blanco Orejinegro (BON) y Chino Santandereano (Chino) en la zona montañosa, Hartón del Valle (Hartón) en el valle del río Cauca, Casanareño y San Martinero en la Orinoquía (Martínez, 2004). Estas razas son el producto de un largo proceso de selección natural de los primeros bovinos introducidos por Cristóbal Colón durante la conquista Española (Rouse, 1977). Los primeros bovinos que llegaron a América, arribaron a la isla denominada La Española (hoy Santo Domingo) y desde allí entraron a Colombia por Santa Marta

formando el primer núcleo ganadero del país. Posteriores ingresos se realizaron por oriente, con ganados importados desde Venezuela y por el sur desde Ecuador. (Pinzón 1984). Los descendientes de esas importaciones coloniales adquirieron características adaptativas de gran importancia, como tolerancia al calor y la humedad, resistencia a ciertas enfermedades infecciosas, alta eficiencia reproductiva y longevidad (Pinzón 1984, Carvajal Carmona, 2003), lo cual incrementó su valor como recurso genético. Algunas de las características externas comunes en las razas criollas colombianas son el pelaje de color amarillo, excepto en el BON, presencia de cuernos, excepto en el ROMO, orejas pequeñas, piel pigmentada y ombligo corto (Martínez, 2004). Dada la importancia del criollo y la disminución considerable de su población, el estado colombiano implementó políticas de conservación en donde se adelantan programas de caracterización morfológica, zootécnica y genética. Como aporte a esta caracterización, el presente

trabajo pretende estimar la variabilidad genética y relaciones filogenéticas de 6 razas criollas colombianas y la raza Brahman mediante la genotipificación con 12 marcadores tipo microsatélite.

Materiales y Métodos

Para la genotipificación con microsatélites, se analizaron 80 animales, no emparentados, representantes de 6 razas bovinas criollas colombianas: Romosinuano (10) (Figura 1), Costeño con Cuernos (10) (Figura 2), Blanco Orejinegro (10) (Figura 3) y San Martinero (10) (Figura 4), provenientes de núcleos de conservación del Ministerio de Agricultura (CORPOICA), Casanareño (10) (Figura 5) y Hartón del Valle (10) (Figura 6), provenientes de núcleos comerciales privados. Adicionalmente, se incluyeron animales de la raza Cebú Brahman (10) y animales de la raza Española Pirenaica (10) como control externo. El ADN se obtuvo a partir de muestras de semen congelado o de sangre



Figura 1. Toro de raza Romosinuano.



Figura 2. Toro de raza Costeño con cuernos.



Figura 3. Toro de raza Blanco Orejinegro.

Tabla 1. Marcadores microsatélite y secuencias de los iniciadores utilizados en el presente estudio.

Marcador	Crom	Secuencia de iniciador
ETH 10	5	GTT CAG GAC TGG CCC TGC TAA CA CCT CCA GCC CAC TTT CTC TTC TC
ETH 225	9	GAT CAC CTT GCC ACT ATT TCC T ACA TGA CAG CCA GCT GCT ACT
ETH 3	19	GAA CCT GCC TCT CCT GCA TTG G ACT CTG CCT GTG GCC AAG TAG G
BM1818	23	AGC TGG GAA TAT AAC CAA AGG AGT GCT TTC AAG GTC CAT GC
BM1824	1	GAG CAA GGT GTT TTT CCA ATC CAT TCT CCA ACT GCT TCC TTG
HEL 13	11	TAA GGA CTT GAG ATA AGG AG CCA TCT ACC TCC ATC TTA AC
HEL 5	21	GCA GGA TCA CTT GTT AGG GA AGA CGT TAG TGT ACA TTA AC
HEL 1	15	CAA CAG CTA TTT AAC AAG GA AGG CTA CAG TCC ATG GGA TT
INRA 005	12	CAA TCT GCA TGA AGT ATA AAT AT CTT CAG GCA TAC CCT ACA CC
INRA 063	18	ATT TGC ACA AGC TAA ATC TAA CC AAA CCA CAG AAA TGC TTG GAA G
ILSTS030	2	CTT AGA CAA CAG GGG TTT GG CTG CAG TTC TGC ATA TGT GG
BMC 1009	5	ACC GGC TAT TGT CCA TCT TG GCA CCA GCA GAG AGG ACA TT

según disponibilidad. El protocolo de extracción de ADN se desarrolló de acuerdo con los protocolos descritos por Sambrook *et al*, (1989).

Genotipificación

Se utilizaron 12 microsatélites, 10 de ellos tomados del grupo de sistemas genéticos

recomendados por la FAO para estudios de variabilidad genética (Tabla 1). La amplificación se realizó mediante PCR multiplex con 50 ng de ADN, 200 μ M de dNTP (Pharmacia Biotech, USA), 0.5 μ M de cada uno de los iniciadores directo y reverso, 2U de Taq ADN polimerasa (Promega, USA) y 2.25 mM de MgCl₂ (Promega, USA). El volumen total de la reacción fue de 25 μ l. La PCR se realizó en un termociclador PTC 100



Figura 4. Toro de raza San Martinero.

(MJ Research, INC) programado con un ciclo de plataforma.

Los productos de amplificación junto con un marcador de peso molecular de 10 pb y 25 pb (Invitrogen, USA) fueron separados en geles de poliacrilamida al 6% (59:1) en condiciones denaturantes (Urea 7M) a 1 800 voltios por 3 horas. Para la visualización de los fragmentos, los geles fueron teñidos con nitrato de plata y su tamaño se calculó por medio del programa GeneSnap de SYNGENE (Figura 7).

Análisis de la información

Para el análisis de la genética de poblaciones se utilizó el programa GENE POP versión 3.3

(Laboratoire du Genetique et Enviroment, Montpellier, France), y las distancias genéticas se calcularon mediante tres metodologías (Nei, Cavalli- Sforza y Reynolds) incluidas en el programa Phylip (Felsenstein, 1993). Para la construcción del árbol se utilizó la distancia de Nei y el algoritmo UPGMA incluido en el mismo programa.

Todas las pruebas y análisis se realizaron en el laboratorio de Recursos Genéticos y Biotecnología Animal de CORPOICA.

Resultados

Por medio de la genotipificación con 12 microsatélites, se identificaron un total de 139 alelos en 8 razas analizadas, con un promedio de 11.58 de alelos por marcador. El marcador ILST030 presentó el menor número de alelos, mientras que los marcadores HEL13 y ETH 10 fueron los más

Tabla 2. Alelos, heterocigocidad e índices Fis por raza.

Raza	Ap	He	Ho	Fis
BON	5.8	0.80	0.72	0.10
CAS	6.5	0.82	0.77	0.06
CCC	5.5	0.77	0.64	0.16
CEB	4.3	0.64	0.60	0.07
EPI	5.8	0.74	0.77	-0.05
HVA	5.9	0.81	0.76	0.06
ROM	5.5	0.78	0.59	0.25
SMA	5.0	0.83	0.78	0.08
Mean	5.5	0.77	0.70	0.095

Ap= Número Promedio Alelos.

He= Heterocigosidad esperada.

Ho= Heterocigosidad observada.

Fis= Coeficiente de consanguinidad.

polimórficos en la población (17 y 14 alelos respectivamente). El número promedio de alelos (NPA) por raza fue de 5.5, con el mayor valor en la raza Casanareña (6.5 alelos) y el menor en la raza Brahman (4.3 alelos) (Tabla 2).

La heterocigocidad promedio fue de 0.7, con los valores más bajos en las razas Romosinuano (0.59) y Brahman (0.6) y los más altos en las razas San Martinero (0.78) y Casanareño (0.7).

El valor del coeficiente de endogamia (Fis) para toda la población de estudio fue de 0.095. (Tabla 2) con valores altos en la raza Romosinuano (0.25) y los más bajos para las razas Casanareño y Hartón del Valle (0.06).

La raza española Pirenaica presentó un valor negativo debido a que el valor de heterocigocidad observado fue más alto que el esperado, mostrando un exceso de heterocigotos. Es importante anotar que la raza Brahman presentó valores de endogamia bajos, por debajo del promedio de la población de estudio.

Para el análisis de diversidad, mediante la metodología que presenta el programa Gene Pop, que computa la diversidad dentro de individuos (1-Quintra) y entre individuos dentro de poblaciones (1-Quinter), se encontró que la raza Brahman presentó los menores valores tanto dentro de individuos como entre individuos (0.59 y 0.65,

Tabla 3. Diversidad dentro de individuos ("1-Quintra") y entre individuos dentro de poblaciones ("1-quinter").

Raza	1-Qintra	1-Qinter	Fis-
BON	0.718182	0.805520	0.1084
CAS	0.780952	0.839341	0.0696
CCC	0.641304	0.767883	0.1648
CEB	0.598131	0.651035	0.0813
EPI	0.785047	0.734138	-0.0693
HVA	0.746988	0.816889	0.0856
ROM	0.595745	0.804420	0.2594
SMA	0.739131	0.806436	0.0835



Figura 5. Toro de raza Casanareño.



Figura 6. Raza Hartón del Valle.

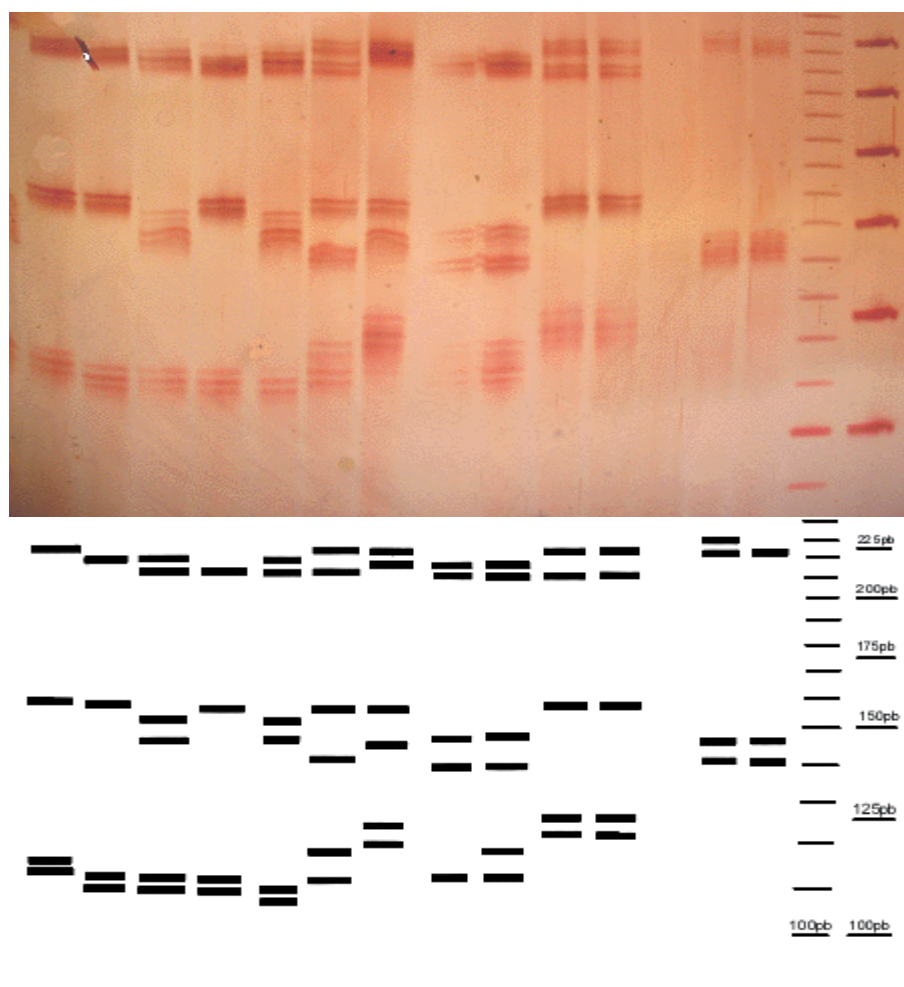


Figura 1. Productos de una PCR multiplex con 3 marcadores microsatélite (ETH10, ETH225 y ETH3). En la parte inferior, esquema del gel mostrando los diferentes alelos comparados con los marcadores de peso molecular 10 bp y 25 bp (Invitrogen, USA).

respectivamente) a pesar de su bajo coeficiente de endogamia. La raza Casanareña presentó los valores más altos de diversidad (0.78 y 0.83, respectivamente). (Tabla 3)

A partir del cálculo de las frecuencias alélicas se realizaron las medidas de distancias genéticas calculadas por tres diferentes metodologías, Nei, Cavalli-Sforza y la distancia de Reynolds, donde se presentaron valores y proporciones de distancia similares entre razas, así como en la topología del árbol (datos no mostrados). Se muestran los datos obtenidos con una de las medidas más comúnmente utilizadas, la distancia genética de Nei (1972), la cual

asume que todas las diferencias genéticas surgen a partir de deriva genética pura y tiene en cuenta un modelo de mutación de alelos infinitos (Tabla 4). En términos generales, la raza española Pirenaica presentó valores de distancia genética altos con respecto a las razas criollas, siendo la San Martinero la más cercana (0.77) y la Romosinuano la más lejana (1.1). Todas las razas de origen *Bos taurus* (criollas colombianas y española Pirenaica) presentaron las mayores distancias con respecto a la raza de origen *Bos indicus* (Brahman) con valores entre 0.71 para la raza Hartón del Valle y 1.75 para la raza española Pirenaica. Dentro de las razas criollas colombianas, las razas BON y

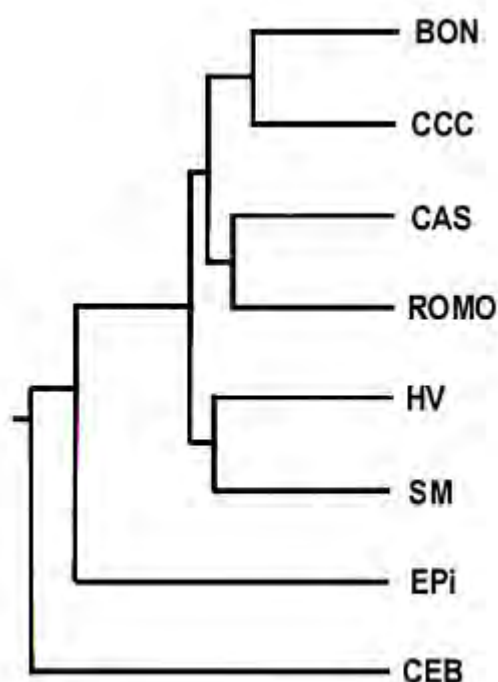


Figura 8. Árbol de relaciones filogenéticas entre seis razas criollas colombianas, una raza autóctona española y la raza Brahman, utilizando la *Ds* de Nei (1972) y el algoritmo UPGMA.

Costeño con Cuernos presentaron los menores valores de distancia genética entre ellas (0.34). La topología del árbol construido con el algoritmo muestra dos grupos separados para las razas *Bos taurus* y *Bos indicus* (Figura 8). La raza española Pirenaica se encuentra separada del grupo que conforman las razas criollas colombianas.

Discusión

En el presente trabajo, se analizaron 7 razas de origen *Bos taurus* (6 razas criollas colombianas y una española) y una raza de origen *Bos indicus* (Brahman), mediante la genotipificación con 12 marcadores tipo microsatélite. El número promedio de alelos (NPA) considerado como buen indicador de variabilidad genética debido a la diversidad alélica, se encontró dentro de los parámetros recomendados por la FAO (sugieren al menos 5 diferentes alelos por locus) para estimación de distancia genética. Un valor más bajo (8.8) reportó un trabajo previo realizado en razas criollas colombianas (Bedoya *et al.*, 2002), debido a la utilización de diferentes y menor número de marcadores. De igual manera, el número promedio de alelos (NPA) por raza encontrado en el presente trabajo (5.5) fue mayor al reporte de Bedoya (2002). Por otra parte, el NPA hallado en la raza española Pirenaica es similar al reportado por Cañón (2001) para esta misma raza.

La endogamia para toda la población (debida a cruces entre individuos cercanamente emparentados) estimada por el coeficiente *Fis* (0.095), y la heterocigocidad observada promedio (0.7), fueron similares a los datos reportados por Bedoya (2002) en razas criollas colombianas (0.13 y 0.67, respectivamente). Es importante anotar, que las heterocigocidades observadas en las razas criollas son altas debido a que estas razas no

Tabla 4: Matriz de distancia genética estándar de Nei (1972) entre seis razas criollas colombianas, una raza autóctona española y la raza Brahman.

Raza	BON	CAS	CCC	CEBU	EPI	HVA	ROMO	SMA
BON	---	0.5074	0.3473	0.8161	0.9242	0.5663	0.5533	0.6334
CAS	0.5074	---	0.6803	0.8171	0.9210	0.6010	0.4593	0.7511
CCC	0.3473	0.6803	---	1.2403	0.8961	0.5759	0.4325	0.5086
CEB	0.8161	0.8171	1.2403	---	1.7529	0.7109	1.1891	0.9874
EPI	0.9242	0.9210	0.8961	1.7529	---	0.9377	1.1047	0.7756
HVA	0.5663	0.6010	0.5759	0.7109	0.9377	---	0.6579	0.4975
ROM	0.5533	0.4593	0.4325	1.1891	1.1047	0.6579	---	0.6126
SMA	0.6334	0.7511	0.5086	0.9874	0.7756	0.4975	0.6126	---

han sufrido procesos de selección tales como aislamiento genético y manipulación biológica.

En general, dentro de las razas criollas, la raza Casanareño presentó la mayor variabilidad, representada en el mayor NPA, la mayor heterocigocidad y el menor coeficiente de consanguinidad. De igual manera, en los análisis de diversidad dentro de individuos y entre individuos, la raza Casanareña presenta los mayores valores. Este resultado no coincide con lo reportado por Bedoya (2002), sin embargo, sus datos se obtuvieron de 4 animales, el menor número de toda la población en su estudio. De manera contraria, en el presente trabajo, la raza Romosinuano presentó la menor variabilidad dentro de las razas criollas, su NPA fue el más bajo después de la raza Brahman y su Heterocigocidad observada fue la más baja de toda la población. Adicionalmente, la raza Romosinuano junto con la Costeño con cuernos presentaron los valores más elevados de coeficiente de endogamia lo que pone estas dos razas como las de menor variabilidad dentro de las razas criollas colombianas (Bedoya *et al.*, 2002). En un estudio de diversidad con ADN mitocondrial se ratifica que la raza Romosinuano presenta la menor diversidad dentro de las criollas colombianas (Carvajal-Carmona, 2003). Estos hallazgos se deben a que esta raza sufrió una disminución de población que se presentó desde el censo de 1986 (3 262 animales puros) hasta el censo de 1999 (2 014 animales puros) (Bejarano, 1986; Martinez, 1999).

La raza Brahman presentó los valores de NPA y de Heterocigocidad más bajos de toda la población de este estudio, lo cual demuestra la baja variabilidad de esta raza frente a las razas criollas. Además, en los análisis de diversidad presentó los valores más bajos, tanto dentro de individuos, como entre individuos. Estos resultados son producto de los procesos de selección externos a los que ha sido sometida esta raza.

Las amplias distancias genéticas observadas entre la raza Española Pirenaica y las razas criollas, podrían sugerir que la

Pirenaica no tuvo mayor influencia durante la conquista española para la formación de las razas criolla. Sin embargo, la raza San Martinero presentó la menor distancia con respecto a la Española, lo que ratifican los resultados de Carvajal-Carmona *et al.* (2003) por análisis del ADN, hallazgo que podría relacionarse con la similitud de las características externas de estas dos razas (Pinzon Martinez, 1984). Rouse (1977) indica que las razas españolas actuales que podrían ser descendientes de los mismos planteles de los cuales provienen los criollos, son la Retinta, la Berrenda, la Cacereña y la Andaluza negra.

En conclusión, se puede decir que las razas bovinas criollas colombianas inscritas en los programas de conservación, muestran un alto grado de variabilidad genética, con su mejor representante en la raza Casanareño, lo cual demuestra su gran valor como patrimonio genético de la nación.

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Characterisation of Kenana cattle breed and its production environment

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Summary

The Kenana cattle breed originates from *Bos indicus* or humped cattle. The name Kenana came from the traditional owners, the Kenana people, who are mainly nomadic and semi-nomadic tribes. The light blue-gray coat is the characteristic color of Kenana cattle. Calves are frequently born with a brown-red coat that tends to change to a permanent gray at three to six months of age. At maturity the average body weights of males and females range from 300-500 kg and 250-350 kg respectively. The total population of Kenana and Butana cattle as major milk producers comprises 25% of the whole cattle population of Sudan. The Kenana homeland is the delta between the White Nile and the Blue Nile. The main system of production is the range system which includes the pastoral and semi-pastoral types. The nature of the nomadism in Kenana is relatively mild. The average milk production per lactation (198-257 days) varies between 1 400 kg and 2 100 kg respectively and maximum production is attained at seven to eight years of age.

Resumen

La raza vacuna Kenana proviene del *Bos indicus* o vacuno con joroba. El nombre Kenana le fue dado por los propietarios tradicionales, los Kenana, que pertenecen a tribus principalmente nómadas o semi-nómadas. El color azul-gris pálido es la característica del manto de esta raza. Las terneras suelen nacer con un manto marrón

rojizo que tiende a cambiar hacia un gris permanente a partir de los tres a seis meses de edad. En la madurez el peso medio corporal de los machos y hembras varía entre 300-500 kg y entre 250-350 kg, respectivamente. La población total de Kenana y Butana como mayor producción lechera comprende el 25% de la población total de vacuno de Sudan. La zona de Kenana se encuentra en el delta entre el Nilo Blanco y el Nilo Azul. El principal sistema de producción es el mixto, que incluye los tipos pastoral y semi-pastoral. El nomadismo en la zona de Kenana es relativamente bajo. La media de producción de leche por lactación (198-257 días) varía entre 1.400 kg y 2.100 kg respectivamente y la producción máxima se obtiene a los siete u ocho años de edad.

Keywords: Population, Systems of production, Milk performance, Genetic improvement.

Introduction

Sudan possesses a wealth of cattle with a population estimated at 39.5 million head and exhibiting an average annual growth rate of 3.6% (Table 1). Livestock plays an important role in the livelihood of a large sector of the population. About 90% of the cattle population is owned by pastoralists mainly concentrated in three major regions; namely Western Sudan, the homeland for Baggara cattle; Mid-Sudan, the homeland for the Kenana and Butana breeds and Southern Sudan where the Nilotic breed is dominant.

Even though the Kenana breed has been exposed to a degree of inter-breeding with

Table 1. Estimates of animal population (in 1 000 head) in Sudan from 1997 to 2002.

Year	Cattle (no.)	Sheep (no.)	Goats (no.)	Camels(no.)
1997	33 102	39 835	36 037	2 936
1998	34 584	42 363	36 498	2 974
1999	35 825	44 802	37 346	3 031
2000	37 093	46 095	3 848	3 108
2001	38 325	47 043	39 952	3 203
2002	39 479	48 136	41 485	3 342
A.A.G.R % ¹	3.6	3.9	2.9	2.4

¹A.A.G.R = Average annual growth rate.

Source: State Ministry of Animal Resource (Statistics and Information Department, 2002).

the Western Sudan Zebu and probably the Nilotics, in addition to the crossbreeding with exotic breeds, it is still believed that this process has not seriously endangered the true breed. Therefore the objectives of this study were to discuss the characteristics of the Kenana breed including information about its origin, description, population, system of production and performance and to emphasize attempts for improvement.

History and Description of Kenana cattle breed

The Kenana breed has originated from the humped *Bos indicus* or Zebu. It has been suggested by Payne (1964) that Zebu cattle were historically imported into Africa following the movement of migratory people into the continent, and represent the ancestry of the vast majority of cattle breeds found there today. Other sources consider that Kenana cattle are the result of inter-breeding the Nilotic Sanga cattle with the short-horn Zebu during tribal migration before recovered history (Rouse, 1970). Sanga cattle are a cross between the Hamitic and the long horn *Bos indicus*. The name Kenana came from the owners also called the Kenana, who are mainly nomadic and semi-nomadic tribes. Mason and Maule (1960) described Kenana as a sub-type of the Northern Sudan Shorthorn Zebu.

The characteristic colour of the Kenana is light blue-gray, with gradation from nearly white to steel gray. Shading to nearly black is common on the head, neck, hump, hind quarters and legs. Black points are also seen on the muzzle, horns, tailtip and eyes. Calves are frequently born with a brown-red coat that tends to change to the permanent gray at three to six months of age. The head is long and coffin-shaped with a thin face (Figures 1 to 4). The horns are short and seldom exceed 30-35 cm, and they are relatively shorter in males than in females. Even though a total lack of horns is exceptional, animals with loose horns are very common. The hump is cervico-thoracic in position, it is large in males and tends to hang over at the rear, but is less developed in females. The dewlap is large and prominent in males. At maturity (about five years) the average body weights of males and females ranges from 300 kg to 500 kg and 250 kg to 350 kg respectively depending on the managerial conditions (Saeed *et al.*, 1987).

Population

Among the northern Sudanese breeds, the Kenana and Butana are considered the major milk producers. The estimated numbers of the two breeds comprise 25% of the total cattle population in Sudan (El-Taher, 1999). The homeland of the



Figure 1. A typical mature Kenana bull.



Figure 2. A typical mature Kenana cow.



Figure 3. Kenana cow with loose horns.

Kenana is the delta between the White Nile and the Blue Nile. It has also spread along the western and eastern banks of the White Nile and the Blue Nile respectively in a triangular area bounded by the cities of Sinnar, Singeh, Rosiris and Kusti (Figure 5). The breed is also found in northern Kordofan state and as far as the area of the Abbassiya in the eastern part of the Nuba mountains. The general description of this habitat is of semi-arid desert scrub with rainfall ranging between 336 mm and 457 mm per year. Under traditional management, the size and composition of herds are influenced by a number of factors such as seasonal availability of water and feed, high market prices and infectious diseases.

Generally herds under nomadic systems tend to include a higher proportion of bulls than those required for breeding purpose and this is related to the social and traditional behaviour of the nomads who put much more emphasis on the number of cattle in a herd as a sign of prestige rather than the proportion of males to females. It is also expected that a large size herd will contain relatively more bulls at different ages than those of a small size because the smaller herd

owners seek to replace excess male calves with females bought from the nearby markets. For breeding purposes owners select the larger sized bulls to serve the cows in a ratio of approximately 1:25. At Umbanein Research Station situated on the western bank of the Blue Nile approximately 10 km from Singeh city (Figure 5), workers suggested a herd structure composed of 42% adult cows, 33% heifers (1-4 years), 23% calves and 2% breeding bulls (Saeed *et al.*, 1987). Generally there is no specific breeding season, however most of the cows conceive during the rainy season when pasture is rich and abundant.

Systems of Production

In general the systems of production for cattle in Sudan are not well characterized. The traditional range grazing system is considered to be the most common and is the system under which more than 80% of livestock is raised. It includes the pastoral and semi-pastoral types. The pasture zone in the country extends in a wide belt between the northern desert and the southern forest

for a distance of 1 600 kilometres from east to west and 800 kilometres from north to south. Annual rainfall varies from 250 mm in the north to 875 mm before the humid areas in the south are reached. Kenana region is located in a semi-arid zone which is characterized by three marked seasons, namely winter (November-February), hot or dry summer (March-June) and wet summer (July-October). The latter is considered to be the rainy season. According to meteorological data in Kenana region, the average annual rainfall is 356 mm, while the peak of the rainy season occurs in August (114 mm) and the least wet time being in October (10.6 mm). There are also some rains in May and June. Humidity is relatively high in the wet summer (80.0-63.0 %) and low in the dry summer (60.0-27.0 %). The mean daily temperature is 27.4°C with the highest and lowest temperatures of 45°C and 10.8°C recorded in May and January respectively.

Generally the types of natural vegetation in Sudan vary with the rainfall, however in Kenana region they are predominantly herb and some types of grass of the genus *Aristida*.

Acacia trees are also commonly seen. Cattle owners who are mostly nomads or semi-nomads seasonally migrate with their herds and gather around the areas rich in water and grass. Milk production excess to the calves' needs is taken to the nearest town or dwellings to be sold as a source of cash. Seasonal cheese plants may be established by merchants in association with cattle owners' settlements. Nomadism for the Kenana breed is milder than that experienced by the cattle in western Sudan where the Baggara cattle usually pass through a very long and tough migratory process. The Kenana homeland partially extends into an irrigated area of the Elgezira scheme where a variety of crops are grown. Therefore the post harvest crop by-products provide a better chance for settlement during this period of time. This system could be described as transhumance where pastoralists return to their villages and spend the rainy season cultivating their lands.

More than 80% of milk production in big cities and towns in Sudan is still provided by the traditional sector. Most of the dairy farms



Figure 4. Polled Kenana bull.



Figure 5. Sudan map showing Kenana homeland. The delta between the white and blue niles extended along the triangular area bounded by cities of Sinnar, Singa, Roseries and Kosti.

include small or mid-size herds (2 050 milking cows) which are mainly Kenana and its crosses with exotics. Feeding regimes in these farms rely on roughage and concentrates. A number of fodder crops such as sorghum bicolor (locally called Abu-Sabeen), pioneer (a variety of hybrid sorghum) and sweet potato are grown in irrigated lands as cash crops. Clitoria and cowpea (*Dolichos lablab*) are also available in winter and the dry summer. Concentrates (a mixture of sorghum, wheat bran, ground nut cake, minerals and vitamins) are provided to lactating cows in proportion with their milk production. A traditional housing system constructed from iron bars, corrugated iron sheets and other local materials such as wood and hay is common. The houses are partially shaded to accommodate animals and to protect lactating cows from excessive sun and rain. Small herd owners may keep their animals in yards surrounded with fences made of wood and hay only (locally

called zareebah). Although A.I centres are found in big cities, natural mating using superior Kenana or crossbred bulls is predominantly practised.

In general farmers do not pay much attention to the importance of keeping records, thus the recording system is poor. The commonly recorded diseases include mastitis, babesiosis, theileriosis, fasciolosis and coccidiosis. Vaccination against brucellosis is not common, however it might be administered to calves of more than six months of age. Veterinary services are available in different forms to fulfil the requirements of the large animal population in the country. Veterinary centres including well trained personnel are located in areas of cattle concentration, while mobile clinics seasonally follow the migratory routes of livestock. Vaccination against infectious diseases such as rinderpest, black quarter, anthrax, haemorrhagic septicemia and contagious pleuro pneumonia is freely and routinely practiced. Recently the government has established a national vaccination program, in collaboration with regional and international organizations aiming to declare Sudan free of animal infectious diseases (Category A).

Even though Kenana cattle are characterized by a good body conformation, they are not considered as a major source of beef in the country. Occasionally bull calves (one to two years) may be kept in yards and fed regularly on agricultural by-products for a few weeks to improve their carcass characteristics.

Performance

The Kenana breed has been classified as among the highest milk producing northern Sudan Zebu. According to several reports (Alim, 1960; El Amin and Osman, 1971; Saeed *et al.*, 1987; and Abdalla *et al.*, 1990) the average milk production per lactation (198-257 days) varies between 1 400 kg and 2 100 kg. Data analysis included 1 626 observations from University of

Table 2. Means and standard deviations of some productive and reproductive traits of Kenana cattle.

Parameters	No.	Average±S.D	C.V %
TMY (kg)	1 056	1 695±776	45.8
210-d (kg)	1 056	1 270±580	45.7
MPD (kg)	1 056	6±2.5	41.2
LL (days)	1 056	289±92	31.8
AFC (month)	233	57±16	28.1
CI (days)	947	467±133	28.5
DP (days)	74	167±23	—
BW (kg)	—	23.7±0.7	—

TMY = total lactation milk yeild; 210-d = standerized 210 days yeild; MPD = milk per day lactation; LL = lactation length; AFC = age at first calving; CI = calving interval; DP = dry period; BW = birth weight.

Source: University of Khartoum and Abu Na'ama Dairy Farms.

Khartoum Dairy Farm (Table 2) showed that the total lactation milk yield (305 days) and the standardized milk yield (210 days) were 1695 kg and 1270 kg respectively (Ageep, 2002). Results from Nisheisheiba Research Station showed that milk fat and solid not fat (SNF) varied with lactation season in a range of 4.2% to 5.4% and 8.7% to 9.0%, respectively. In general, data on the reproductive and productive performance of the Kenana breed under nomadism is very scant, therefore the results which were

obtained from the research stations are considered as the most available. The average birth and weaning (120 days) weights of Kenana at Umbanein Research Station was found to be 23.0 kg and 52.0 kg respectively (Saeed *et al.*, 1987; El-Habeeb, 1991) whereas the dressing percentage was 55%. Traditionally Kenana is used for milk, meat and hide production. Bulls are also used as draught animals during the migration season.



Figure 5. Kenana calf three months old.

As for the reproductive performance of Kenana cattle, a slight seasonal difference in the number of births has been observed at Umbanein Research Station. Most births take place in December and January and the least between July and September. Under traditional management practices, the seasonality is very marked, with more than 60% of all calving taking place in a three-month period related to conception in the previous rainy season. A relatively great age at first calving has been reported at different research stations, ranging between 38.4 months at Gezira Farm (Alim, 1960) to 50 months at Umbanein Station (Saeed *et al.*, 1987). There is no data for the age at first calving under nomadic systems, however it is believed to exceed the range reported at research stations because of poor and fluctuating managerial conditions in the traditional sector. The range for the number of services per conception at different seasons was estimated to be 1.4-1.8 (Saeed *et al.*, 1987). Researchers have suggested a slightly higher number of services per conception under the pastoral system (2.5 for Western Baggara cattle). The calving interval at Umbanein Station was found to be 485 days which is longer than those reported at Gezira Farm (368-405 days). The reproductive life-span is reported to be within the range of 4 to 5.4 years. The

reproductive efficiency of dairy cattle depends upon the regular production of offspring. As for Kenana cattle, the reproductive efficiency seemed to be characterized by the late age at first calving, and long calving interval. Therefore, the peak of production is expected to be attained relatively late (seven to eight years).

Calf mortality data at Umbanien Station demonstrated that the greatest risk was experienced during the neonatal period and up to the age of one week. Figure 6 and 7 show calves at the age of three and six months old, respectively. The overall mortality rate to one year was found to be 16.6% (Saeed *et al.*, 1987), however for calves of more than one year the mortality rate was much more reduced such that 75.6% of all animals born survived to ten years of age. Most of the deaths during pre- and post-weaning periods are due to pneumonia, digestive problems and general weakness (Table 3).

Under traditional management calf and adult mortality are considerably higher.

Current Effort for Genetic Improvement of Kenana

The governmental effort to genetically improve the indigenous cattle breeds of

Table 3. Pre and post-weaning deaths of Kenana calves by season and sex.

	Winter			Dry summer			Wet summer			Overall	
	M	F	T	M	F	T	M	F	T	M	F
<i>Pre-weaning</i>											
N born	246	237	483	306	307	613	216	244	460	768	788
Death	18	18	36	28	27	55	35	36	71	81	81
Percentage	7.2	7.3	7.3	8.8	8.5	8.7	14.5	13.6	14.0	10.0	9.7
<i>Post-waning</i>											
N weaned	181	208	389	228	219	447	278	280	558	687	707
Death	8	12	20	12	9	21	56	23	79	76	44
Percentage	4.3	5.9	5.2	5.2	3.7	4.7	20.3	7.8	13.4	8.9	5.7

Pre-weaning = 1-4 month, post-weaning = 4-8 month.

M, F, T = male, female and total.

Source: Umbanein Research Station.



Figure 6. Kenana calf less than six months age.

Sudan and conserve the endangered ones has been going on since the early 1940s, and has consequently led to the establishment of a number of research centres in the areas of livestock concentration. Umbanein Research Station was established in 1957, with the primary objective of improving the Kenana breed for milk and beef production through a continuous selective breeding programme. In the early 1960s a multi-purpose research centre was established at Kuku district in Khartoum North province. It includes several animal production units, among which an A.I. centre is considered to present the hope of imminent progress in animal breeding. At the same time the research effort which was carried on at Khartoum and Gezira University farms indicated the probability of achieving some genetic progress in the milk production of Kenana cattle (Alim, 1962; Osman, 1972). However because of the small herd sizes in these farms, in addition to financial barriers to sustaining such a long term selection programme, progress in genetic improvement has not been attained.

A main goal of these research centres is to maintain small purebred nucleus herds of

Kenana and other local breeds, and they have proved to be successful in this respect. Very recently joint efforts between the government and the private sector have led to the establishment of financial institutions for agriculture, some of which are entirely devoted to livestock development such as the Animal Resource Bank. These institutions are supposed to play an important role in improving the socio-economic life of the nomadic tribes and promoting animal production research.

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The Damascus (Shami) goat of Cyprus

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Introduction

The Damascus goat, also known as the Shami, is a native breed of Syria and other Near East countries. It was imported into Cyprus some 70 years ago to upgrade the local Cypriot goat population. For over 40 years it has been improved through genetic selection for milk and meat. The Damascus goat was one of the breeds that the Technical Consultation of FAO/UNEP on Animal Genetic Resources, Conservation and Management agreed should be given a high priority due to its qualities.

Appearance and Distinguishable Features of the Breed

The Damascus goat has a reddish brown coat colour consisting mostly of long hair. White spots on the body, legs and face, although not very common, may appear on the animal (Figure 1 and 2). The black coat colour is extremely rare and may appear as a result of the presence of a recessive gene in the population. The ears are long and pendulous measuring between 27 cm and 32 cm in length. It is a rather large breed measuring 78 cm at withers, with a body circumference of 97 cm to 99 cm and an adult live weight of about 65±5 kg for the female and 75±5 kg for the male. The head is long with a Roman nose and the presence of horns in both sexes is associated with inter-sexuality (Hancock and Louca, 1975). The breed carries wattles.

Main Management System

This improved breed, that lives and performs in Cyprus, requires an improved management and feeding environment to express its full genetic potential. Extensive grazing is not practiced and watering facilities are available only during the short grazing hours allowed. The goat can be managed in small or large-size herds. Housing, feeding and other necessary facilities are available. The most common herd size is 200 to 300 goats, but herds of 500 does or more are not rare. The breed is considered as one of the best dual-purpose breeds of the Middle East under semi-intensive or intensive production systems, combining high prolificacy with high milk production. Because of these qualities, its potential for high output and its nutrition requirements during the various phases of the production cycle, the Damascus goat has been extensively studied.

Management and feeding systems, such as suckling regimes, weaning regimes (age of kids at weaning, continuous or partial suckling, etc.), energy and protein requirements of the doe and the kid and fattening practices have also been investigated. The very nature of the production system in which the particular breed performs (semi-intensive to intensive) indicates that natural vegetation and seasonal variation, although important during certain parts of the production cycle, do not play a significant role in the management and nutrition of the breed. With regard to management practices, it is important to note that weaning of kids can be practiced at birth (zero suckling) or at six



Figure 1. A Damascus (Shami) ram.

to seven weeks post partum without serious adverse effects on the growth of the kids. The digestible nitrogen requirements for maintenance of a 65 kg goat (dry, non-pregnant) are estimated at 1.75 kg per kg metabolic ($W^{0.71}$) body weight (Hadjipanayiotou, 1987). The daily energy requirements for maintenance are similar to those of the Chios sheep, i.e., 15.7 MJ of ME during pregnancy (Economides, 1984).

Reproduction Characteristics

The Damascus goat is considered a seasonal breeder. The breeding season starts in late August and extends through mid-December (Mavrogenis, 1988 a). Age at first overt oestrus occurs between 220 and 270 days of age depending on the season of birth of the kids. Live weights at those ages range from 42 kg to 54 kg depending on the type of birth (Mavrogenis, 1988 b). This characteristic allows for the early breeding of kids and the initiation of the productive life at the young age of 13 to 16 months (Mavrogenis and Constantinou, 1983). The reproductive

activity of the goat is restored 43 ± 9 days following parturition (Constantinou, 1981). Fertility is medium to high (80% to 90%), a characteristic of most goat breeds with high milk production. The prolificacy of the breed is among the highest in the region averaging 1.80 kids per doe kidding (Constantinou, 1981; Constantinou *et al.*, 1981). The presence of horns is associated with inter-sexuality and sex ratio is distorted (Hancock and Louca, 1975; Constantinou *et al.*, 1981).

Production Performance

Under the semi-intensive system of production, the breed's performance is moderately high. Birth weights are high and range from 3.5 kg to 5.5 kg depending on the type of birth and the sex (Mavrogenis, 1985; Constantinou, 1989; Mavrogenis and Papachristoforou, 2000). The nutrition requirements for growth before and after weaning have been extensively studied (Hadjipanayiotou and Louca, 1976; Hadjipanayiotou, 1986). Kid carcasses are

less fatty than lamb carcasses, when they are compared at similar slaughter weights or similar slaughter ages. The dressing percentage of kid carcasses at 55% maturity is 50.3% (120 days of age) with a lean content of 55% and a fat content of 26.8% in the best and neck cuts.

Milk Production Potential

The Damascus goat is considered a dual-purpose animal (meat and milk). It is milked principally following weaning, but also during the suckling period, since a large quantity of milk remains in the udder without being utilized by the suckling kids. The practice in Cyprus herds is that only two kids are allowed to suckle as a routine practice. All extra kids from large litters are transferred to artificial rearing units.

Total milk production, including milk produced until weaning, ranges between 350 kg and 650 kg per goat per lactation (Louca *et al.*, 1975). The quantity of milk produced until weaning including that

suckled by the kid(s), is 190 kg to 240 kg, depending on the length of the suckling period (35 or 70 days). Milk production for commercial purposes is high (200 kg to 350 kg per goat per lactation) depending on the management system and the level of feeding (Louca, 1975; Hadjipanayiotou and Louca, 1976; Papachristoforou *et al.*, 1982; Mavrogenis, 1983; Mavrogenis *et al.*, 1985; Constantinou *et al.*, 1985; Mavrogenis *et al.*, 1989). Lactation extends from five to nine months following weaning, although lactations of up to a year are not rare. The fat and protein content of the milk are characteristic for high yielding breeds, ranging from 3.8% to 4.5% for fat and from 4.0% to 4.8% for protein (Economides, 1986). The milking goat responds positively to high protein diets with increased milk output and longer maintenance of lactation at a high level (Hadjipanayiotou, 1987).

Machine milking is progressively replacing hand milking. The practice of twice daily milking can be interrupted for a few days (mostly weekends) and once-a-day milking does not seriously affect total milk



Figure 1. A Damascus (Shami) goat.

production (Papachristoforou *et al.*, 1982). Most morphological traits of the udder can also be favourably manipulated genetically. (Mavrogenis *et al.*, 1989).

Genetic Evaluations

Systematic studies of the description and characterization of the Damascus goat were initiated as early as 1972. The first studies concerned mostly management problems and weaning regimes, since this particular breed required a better environment to express its full potential.

Genetic evaluation has been concerned with production and reproductive traits, such as part (60-day, 90-day and 150-day) and total milk production, lactation length, fertility and prolificacy of the goat as well as the total weight of the litter at birth and at weaning. Moreover, the individual performance of kids, from birth to the age of 140 days, was also investigated. Growth rates both before and after weaning were included in the genetic evaluation studies.

Management System under Private Farm Conditions

This farm established in 1929 is located in the south of the island of Cyprus near the village of Pissouri, some 45 km from the city of Limassol (Figure 3 and 4). It is established on a low hill area (altitude 50 m from sea level) and prevailing temperatures in the area range between 5° C and 20° C in the winter and 28° C to 35° C in the summer. Humidity in the summer months ranges between 40% and 60%.

The unit in 2004 comprised of 460 milking goats (Figure 5) that were milked twice daily at equal milking intervals (at 5:00 h and 17:00 h). The management system utilizes not only the seasonal character of the breed but also artificial induction of oestrus during the anoestrous period of the year. The main purpose of the practice is to provide the market with a more or less constant supply of milk which is sent to the nearby processing plant for the conversion of milk into the traditional Halloumi cheese. No artificial insemination is practiced on the



Figure 1. Damascus (Shami) goats in a shelter.



Figure 4. A flock of Damascus (Shami) goat.

farm. Mating is carried out through selected sires and the system used for the identification of parentage relies on a group mating scheme of assigning one male to 25 females.

The farm practices no suckling. All kids are removed from their dams immediately after birth and are transferred to the artificial rearing unit that is designed to provide colostrum (for two days) and/or a reconstituted milk replacement (Table 1) *ad libitum* for a period of 45 ± 3 days when kids are weaned. Creep feed and alfalfa hay is also provided *ad libitum*. Fresh water is available through automatic watering units. Following weaning all kids are transferred to rearing-fattening pens where they are fed on concentrates and barley hay *ad libitum* until the age of 120 days. Sexes are segregated at that age and males and females, selected for breeding (replacements), are separated and housed in lots of 25 to 30 animals. Feeding is again at will on both concentrates and barley hay. By four months of age female kids reach an average weight of 30 kg to 34 kg and males 33 kg to 36 kg. All animals selected for

breeding at four months of age enter an intensive immunization and veterinary control program. The mature (adult) body weight of the does ranges from 60 kg to 80 kg and of the bucks from 80 kg to 100 kg.

Young females are introduced to bucks early in pubertal life when they exhibit first oestrus (between 220 and 270 days of age) and continue breeding for an average of six years after which they are sold to other farmers or are utilized for meat. Bucks begin their reproductive life at circa nine months of age and remain in the production system for a maximum of two years. Related mating and consanguinity is minimized by separating males from females and only allowing mating between related individuals beyond third degree relatives.

All goats are milked immediately following parturition and the first milk (colostrum) is fed to the kids. They are subsequently milked for 305 days twice daily unless daily production drops below one kg per day when they are milked once a day. A completed lactation is one that lasted 305 days unless they become pregnant in

Table 1. Content of ingredients, trace elements and additives of milk replacer used on the private unit.

Ingredients (%)		Additives (per kg mixed feed)		Trace elements	
Crude protein	23.0	Vitamin A	60 000 I.E.	Iron	72 mg/kg
Crude fat	20.0	Vitamin D3	6 000 I.E.	Copper	10 mg/kg
Crude fiber	0.3	Vitamin E	60 mg	Manganese	30 mg/kg
Crude ash	7.8	Vitamin C	270 mg	Selenium	0.15 mg/kg
Calcium	0.85	Vitamin K3	3 mg	Zink	32 mg/kg
Phosphorus	0.75	Vitamin B1	9 mg	Cobalt	0.25 mg/kg
Sodium	0.65	Vitamin B2	14.4 mg	Iodine	0.35 mg/kg
		Vitamin B6	4.2 mg		
		Vitamin B12	0.04 mg		
		Nicotinic acid	60 mg		
		Pantothen acid	30 mg		
		Choline chloride	375 mg		
		Biotin	0.2 mg		
		Folic acid	0.4 mg		

which case they are removed from the milk producing flock 60 days prior to parturition. No extension is carried out for shorter lactations, and longer lactations are standardized to 305 days.

The feeding system for lactating goats consists of a commercial concentrate feed

containing (per tonne finished feed) 350 kg barley, 150 kg corn, 110 kg soybean meal, 30 kg salt and limestone and 10 kg of a vitamin mixture (14% CP), and cereal hay and straw all fed *ad libitum* until daily milk production drops below 1.5 kg when concentrates are fed based on requirements for milk yield.



Figure 5. A flock of Damascus (Shami) goat.

Performance Evaluation at the Private Farm

Performance recording was initiated in 2000 when only 100 animals were recorded. Hence, evaluation on the basis of performance records for the years 2000 to 2003 as well as on the basis of parity is not uniform with respect to the number of observations. Milk production is presented in Tables 2 and 3 for year and parity effects, respectively (Figure 6). It is clear from the means listed in table 2 that milk yield increased considerably from 2000 to 2003. This is mostly attributed to proper culling and replacement practices through the years. The high milk production observed in this private unit reflects the fact that milking was practiced right from parturition. It appears that the suckling stimulus that was decisive in the early 1980's has diminished in importance. Louca *et al.* (1975) and other investigators (Louca, 1975; Hadjipanayiotou and Louca, 1976) observed high milk production in goats separated from their kids at two days following birth but which was

somewhat lower than that found in the present study. With respect to parity milk yield, this was highest at the third parity and tended to decrease thereafter. Similar findings have been reported (Mavrogenis, 1983; Mavrogenis *et al.*, 1985; Constantinou



Figure 6. Udders of Damascus (Shami) goats before milking.

Table 2. Milk production and prolificacy of Damascus (Shami) goats by year of production on the private unit.

Year of production	Milk yield (kg)			Prolificacy		
	N	Mean	SD	N	Mean	SD
2000	102	640.4	106.2	102	2.62	0.83
2001	334	668.0	100.6	336	2.39	0.77
2002	386	708.5	114.5	387	2.36	0.75
2003	459	731.9	144.0	459	2.27	0.73

Table 3. Milk production and prolificacy of Damascus (Shami) goats by parity of doe on the private unit.

Parity of doe	Milk yield (kg)			Prolificacy		
	N	Mean	SD	N	Mean	SD
1	80	635.2	165.2	80	1.92	0.57
2	168	674.9	123.1	168	2.09	0.63
3	606	726.9	120.2	611	2.31	0.72
4	427	686.5	117.5	427	2.60	0.81

Table 4. Mean birth weights of Damascus (Shami) kids averaged over parity of dam and type of birth on the private unit.

Birth weight (kg)	Sex of kid	
	Males	Females
N	428	372
Mean	4.37	3.91
S.D.	0.74	0.72

et al., 1985; Mavrogenis *et al.*, 1989) for the Damascus breed.

Kid growth data are very limited because of the small number of kids recorded following birth. The unit has only recently established a system of evaluation based on post-weaning growth of the kids and the milk production of their dam but data are limited and information other than birth weights is not provided. Live weights at birth, however, are satisfactory (**Table 4**) and consistent with previous reports of other studies (Mavrogenis, 1985; Constantinou, 1989; Mavrogenis and Papachristoforou, 2000). Males were heavier (4.4 ± 0.7 kg) than females (3.9 ± 0.7 kg) when averaged over type of birth and dam parity, and reflect current breed averages.

The Cyprus Damascus (Shami) goat is an excellent, highly adaptive and hardy goat. Experience from local farms and import countries confirm that it can be used both in purebreeding or crossbreeding programs to upgrade milk yields in local populations or dual purpose production systems. The farm has considerable experience exporting the Cyprus Damascus (Shami) goat to more than 15 Middle East and Gulf States over 20 years. Detailed studies in Libya demonstrate that the performance of purebred or crossbred Damascus (Shami) goats surpasses that of the local populations.

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Characterisation of Salem Black goats in their home tract

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Summary

The Salem Black is an important meat goat breed in the north-western part of Tamil Nadu, India. The native tract of this breed is the Salem, Dharmapuri, Krishnagiri, Erode, Karur and Namakkal districts of Tamil Nadu. Salem Black goats are tall animals, completely black in colour and reared mainly for meat. The average herd size of Salem Black goats was 31, of which there were 1 buck, 23 does and 7 kids. The chest girth, body length and height at withers of Salem Black goats at full mouth age were 79.6 ± 1.1 cm, 75.0 ± 1.5 cm and 86.0 ± 1.6 cm, respectively in males and 73.1 ± 0.6 cm, 69.8 ± 0.5 cm and 75.5 ± 0.8 cm, respectively in females. The body weight of Salem Black goats at full mouth age was 38.5 ± 1.0 kg in males and 29.5 ± 0.6 kg in females. The average age at first mating was 9.5 ± 0.4 months in males and 9.7 ± 0.2 months in females, and the average age at first kidding was 14.8 ± 0.2 months. The percentage of animals producing singles, twins, triplets and quadruplets was 54.1, 40.0, 8.2 and 0.4, respectively. Salem Black goats are allowed to browse extensively as a herded group for about seven to eight hours per day and are housed mostly (80%) during the night. Farmers kept breeding bucks, when available, in the herds at all times and exercised no controlled mating. The mortality rate in kids and adults was 7.5% and 2.3% respectively.

Resumen

La raza caprina Salem Black es una importante raza de carne de la zona noroeste de Tamil Nadu en la India. Las zonas de origen de esta raza se encuentran en Salem, Dharmapuri, Krishnagiri, Erode, Karur y Namakkal, en la región de Tamil Nadu. Estos animales son altos, de manto totalmente negros y se crían principalmente para carne. La media de los rebaños de Salem Black era de 31 cabezas, de las cuales había un macho, 23 hembras y 7 cabritos. La circunferencia torácica, longitud corporal, y altura al garrote de esta raza en edad adulta es de $79,6 \pm 1,1$ cm, $75,0 \pm 1,5$ cm y $86,0 \pm 1,6$ cm en machos y de $73,1 \pm 0,6$ cm, $69,8 \pm 0,5$ cm y $75,5 \pm 0,8$ cm en hembras. El peso corporal de la Salem Black en edad adulta es de $38,5 \pm 1,0$ para los machos y de $29,5 \pm 0,6$ kg en las hembras. La edad media al primer celo es de $9,5 \pm 0,4$ meses en los machos y de $9,7 \pm 0,2$ meses en las hembras, y la media de edad al primer parto de $14,8$ xx meses. El porcentaje de partos simples, dobles o triples y cuádruples es de 54,1; 40,0; 8,2 y 0,4, respectivamente. La raza Salem Black está capacitada para el pasto extensivo en rebaño durante siete u ocho horas diarias, y la mayoría pasan la noche a cubierto (80%). Los ganaderos mantienen al macho dentro del rebaño siempre que pueden sin ejercer ningún tipo de control sobre las montas. La mortalidad media de las crías y adultos es de 7,5% y 2,3% respectivamente.

Keywords: *Geographic distribution, Morphological characteristics, Reproductive*

performance, Breeding, Husbandry, Disease prevalence, Marketing.

Introduction

Goats contribute meat, milk, skin and fibre, as well as manure and serve as the sole or subsidiary livelihood for a large number of small and marginal farmers and landless labourers in India (Anon., 1994). Tamil Nadu is situated in the southern part of India and has a goat population (as per 1998 census) of 5.39 million (Report, 1998). Annually, goats provide 17.32 thousand tonnes of meat, representing 35% of the total meat obtained from food animals in the state (Sastry, 1995). In addition 4 880 000 pieces of skin are obtained as by-products every year (Report, 1992). In spite of the substantial contribution of goats to the rural economy no serious attempt has been made to document their genetic diversity and production potential in their breeding tract. Tamil Nadu has two recognized goat breeds, the Kanni Adu (Acharya, 1982; Thiruvankadan *et al.*, 2000a; Thiruvankadan *et al.*, 2000b) and the Kodi Adu (Jain *et al.*, 2000). Apart from these breeds of goat, Tamil Nadu has another goat breed, the Salem Black goat, which needs characterization and recognition. The earlier study (Mariadas, 1996) on Salem Black goats is not comprehensive and the physical and production traits are not reported. Hence, this study has been made in the Salem Black goat breeding tract to document the distribution, morphological, physical, production and reproduction traits of Salem Black goats.

Materials and Methods

A study was undertaken in 57 herds belonging to 12 villages in the breeding tract. Particulars on physical measurements and body weights of Salem Black goats were recorded for 187 males and 461 females. Data on the reproduction performance of

males (n=36) and females (n=96) were collected from the yearlings and does present in the herd by questioning the owner about each animal specifically. In addition the data on husbandry practices was collected. For analysis the kids were classified as birth, three, six, nine and twelve months and adult animals were classified as two tooth, four tooth, six tooth and full mouth age groups. The data collected were subject to standard statistical analysis as per Snedecor and Cochran (1989).

Results and Discussion

Habitat and geographic distribution

The name Salem Black has been derived from the goat's place of origin and coat colour. The name Salem has been derived from the place Salem (i.e., Salem district in Tamil Nadu) in which this breed actually originated. Since this breed is completely black in colour it has been given the name Salem Black. It is also known as *Karuppuadu*. The breed is distributed in Salem, Dharmapuri, Krishnagiri, Erode, Namakkal and Karur districts of Tamil Nadu (Figure 1) which lie approximately between 10° 35' and 13° 01' N latitude and 76° 5' and 78° 5' E longitude. The elevation of the tract ranged between approximately 150 m and 700 m above mean sea level. The approximate total area of the breeding tract is 29 24 531 km². In the majority of the areas the farmers were rearing only the Salem Black breed of goat, in some places farmers were also rearing Tellicherry and Tellicherry crossbreds in addition to Salem Black goats. The breeding tract of the Salem Black lies in the north-western agro-climatic zone of Tamil Nadu and the climate is generally hot, semi-arid and tropical in nature. Mean annual maximum and minimum temperatures were 34.3° C and 21.9° C, respectively. The mean annual relative humidities recorded at 08.30 h and 17.30 h were 77.2% and 55.1%, respectively. The average annual rainfall was 1 112 mm.

Herd size

The herd size of the Salem Black goat in its breeding tract varied from a few animals (two to five) to relatively large herds (50 to 70) with an average of 31, composed of 23 does, 1 buck and 7 kids. The majority of the farmers had a herd size of 10 to 30 goats. The percentage of farmers having a herd size of 0-10, >10 - 20, > 20 - 30, > 30 - 40 and above 40 was 1.8%, 24.6%, 43.8%, 10.5% and 19.3%, respectively.

Morphological characteristics

Salem Black goats are tall animals with a lean body and a completely black coat (Figure 2 and 3). The head is medium in length with a medium to broad forehead. The profile of the head is straight. The ears are medium-long, leaf like and semi-pendulous. The mean values of ear

length in adult males and females were 17.2 ± 0.3 cm and 16.0 ± 0.1 cm, respectively. The eyelashes are black in colour and the goats have a grey coloured tapering muzzle. In adults, both males and females have horns which are ash grey to grey in colour with no typical horn pattern. The mean values of horn length in adult males and females were 20.0 ± 0.9 cm and 13.7 ± 0.5 cm, respectively. The top line was almost straight. The flank was moderate in size and not too wide. The thigh was lean and not well developed. They have long, lean and straight legs squarely set under the body. The hooves and dewclaws are grey in colour. The tail is thin, medium in length and curled upwards. The mean values of tail length in adult males and females were 20.4 ± 0.4 (32) cm and 17.6 ± 0.1 (46) cm, respectively. The udder is not well developed. It is small and round and tightly attached to the belly with small conical teats placed laterally.

Physical measurements

In kids, the mean ($\pm$ SE) chest girth, body length and height at withers of Salem Black goats pooled over sexes at six months of age were 52.3 ± 0.5 (60) cm, 51.6 ± 0.5 cm and 58.8 ± 0.5 cm, respectively and at 12 months of age were 61.8 ± 0.6 (46) cm, 59.5 ± 0.5 cm and 67.4 ± 1.1 cm, respectively. These body measurements increased progressively as the age advanced and at full mouth age they were 79.6 ± 1.1 (7) cm, 75.0 ± 1.5 cm and 86.0 ± 1.6 cm, respectively in males and 73.1 ± 0.6 (44) cm, 69.8 ± 0.5 cm and 75.5 ± 0.8 cm, respectively in females. Based on height at withers, goats are classified as large (>65 cm), small (51-65 cm) and dwarf (<50 cm) (Devendra and Burns, 1983). Accordingly Salem Black goats can be grouped under large breeds. In general, the males had greater body measurements than females. The coefficient of variation for the body measurement at different age groups ranged from 5.5% to 10.8 %.



Figure 1. Breeding tract of Salem Black goat in Tamil Nadu, India.



Figure 2. Salem Black goat: a buck.



Figure 3. Salem Black goat: a doe.

Body weight

The mean ($\pm$ SE) body weight of Salem Black kids at birth, three, six, nine and 12 months of age was 2.6 ± 0.3 (22) kg, 8.6 ± 0.2 (58) kg, 12.1 ± 0.4 (14) kg, 14.4 ± 0.5 (14) kg and 22.6 ± 1.5 (14) kg, respectively for males and 2.4 ± 0.1 (23) kg, 8.5 ± 0.2 (75) kg, 12.1 ± 0.3 (50) kg, 13.9 ± 0.3 (14) kg and 18.6 ± 0.3 (14) kg, respectively for females. In adults, the body weight at two tooth, four tooth, six tooth and full mouth age was 25.8 ± 0.8 (30) kg, 28.5 ± 0.8 (8) kg, 36.4 ± 1.4 (12) kg and 38.5 ± 1.0 (15) kg, respectively for males and 22.5 ± 0.5 (54) kg, 24.7 ± 0.6 (65) kg, 26.4 ± 0.5 (45) kg and 29.5 ± 0.6 (53) kg, respectively for females. The coefficient of variation for body weight ranged between 14.2% and 21.2%. In general, the body measurements and body weight of Salem Black goats were lower than those reported for the Kanni Adu and Kodi Adu breeds (Thiruvankadan, *et al.*, 2000b; Jain *et al.*, 2000).

Reproductive performance

The Salem Black goat seems to have good reproduction potential in terms of early sexual maturity and prolificacy. The reproduction performance of Salem Black

goats is presented in table 1. The majority (81%) of females attained sexual maturity between nine and twelve months of age. Maintaining bucks all the time in the herds resulted in the mating of most of the females in the first oestrus. The age at first kidding varied from 11 to 18 months and 75% of the does in the herds studied were reported to have kidded well before the eruption of the first pair of permanent incisors. The multiple birth percentage accounted for 48.6%. On the contrary, Mariadas (1996) reported that the incidence of twin birth was rare in Salem Black goats. The multiple birth percentages observed were lower than those reported for the Kanni Adu and Kodi Adu breeds (Thiruvankadan, *et al.*, 2000a; Jain *et al.*, 2000).

Husbandry practices

Feeding

Salem Black goats are allowed to browse extensively as a herd (Figure 4). They are taken out for browsing up to a distance of three to six kilometres for a period of seven to eight hours daily in the bushes along road sides, uncultivable lands, forest areas and harvested fields. The main sources of fodder are local weeds on the banks of dry and wet

Table 1. Reproductive performance of Salem Black goats.

Character	Number of observations	Mean $\pm$ S.E.	Range	Coefficient of variation (%)
<i>Males</i>				
Age at first mating (months)	36	9.5 ± 0.40	7 to 12	24.1
<i>Females</i>				
Age at first mating (months)	96	9.7 ± 0.20	6 to 13	17.1
Age at first kidding (months)	82	14.8 ± 0.20	11 to 18	11.4
Kidding intervals (months)	62	7.1 ± 0.80	6 to 9	10.8
Mean litter size	440	1.6 ± 0.03	1 to 4	41.9
Litter size (%)				
Singles	440	51.4		
Twins	440	40.0		
Triplets	440	8.2		
Quadruplets	440	0.4		



Figure 4. A herd of Salem Black goats grazing in its natural environment.



Figure 5. An open pen, placed in the harvested field.

lands, leaves from harvested crops and lopped tree leaves. The major fodder trees noticed were *Azadirachta indica*, *Tamarindus indica*, *Ficus benghalensis*, *Albizia lebbek*, *Acacia nilotica*, *Prosopis juliflora*, *Ziziphus mauritiana* and *Acacia leucophloea*. The predominant vegetation seen in the pasture was *Cenchrus ciliaris*, *Cenchrus setigerus*, *Cynodon dactylon* and *Digitaria ciliaris*. During summer months due to the scarcity of fodder the goats are fed with *Acacia* pods, tapioca leaves, rind and thippy and dry fodders like groundnut hay, paddy straw and horse gram hay. Feeding of animals with concentrates was practiced in 33% of the herds studied. The kids are maintained with does milk, local weeds, grasses, tree leaves and harvested crops up to three months of age, after which time they are allowed to browse.

Housing

Salem Black goats are mainly housed during the night. The percentage of animals housed only at night and during both the day and

night was 89% and 11%, respectively. The housing structures consist of open, half open and closed type pens, which are well ventilated. The percentage of farmers with open, half-open and closed type sheds was 75%, 13% and 12% respectively. In open pens, the structure consists of a half walled enclosure made up of bamboo sticks, a night watchman shelter and a special enclosure for kids (Figure 5). In general, the goats are housed in open pens in the harvested fields for manuring purposes and the housing structure is shifted to the nearest place once a day in order to eventually cover the entire field (Figure 6). Generally, the night watchman shelter is placed inside the enclosure and provides a closed area for the animals, and also protects the goats from rain and extreme winter. The kids are housed in special enclosures made of bamboo and palmyra leaves (Figure 7) and they are placed either inside the pens or nearer to the pens. In some of the half open and closed type sheds a small partition is made to accommodate the kids.



Figure 6. Shifting of open pen to nearby place for manuring.



Figure 7. A kid enclosure, made up of bamboo stick and palmyra leaves.

Breeding

When the bucks are kept in the herds, they are with the does at all times and the owner exercises no control over mating. Among the herds studied, 88% of the herds owned males for breeding. The farmers exchange breeding bucks from one herd to another. A few male kids were selected for breeding, others are disposed of at an early age, and almost all the females are retained. Only old does are sold for meat purpose. Bucks are retained for mating up to five years of age and the does are used for breeding until five to seven years of age.

Disease prevalence and survivability

The study revealed the occurrence of enterotoxaemia, *peste des petits ruminants* and foot and mouth diseases for which vaccinations are administered in the face of out breaks. Deworming of the animals is practiced at regular intervals. Salem Black

goats are considered as hardy with low overall mortality. The mortality rate in kids and adults was 7.5% and 2.3% respectively. This indicated its innate resistance to the harsh climatic conditions prevailing in its original habitat.

Marketing

The marketing of live animals was disorganized and involved middlemen and commission agents. The percentage of farmers who sold Salem Black goats in weekly markets or through a broker was 74% and 26%, respectively. In most of the markets trading and pricing is based on muscle thickness at loin and thigh areas. In general, the price of the meat was steady or in an upward trend irrespective of the market price of the live animals.

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Chato Murciano pig breed: genetic and ethnozoological characterization

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Summary

The Chato Murciano is the only surviving breed of pig of those historically farmed in the region of Murcia for their quality meat. At present, it is on the verge of extinction, having a population of only 260 reproductive animals. This paper describes the genetic studies made in the conservation and recovery programme of this breed of pig. A study of the morphological characterization of these animals was carried out first, measuring thirteen quantitative and six qualitative variables in a sample of 24 adult animals, 8 males and 16 females.

Subsequently, investigation was made of the consanguinity of the individuals and of the population as well as the future influence of inbreeding in each generation. Finally, the accuracy and precision of the heterozygote-excess method was evaluated using two data sets from the Chato Murciano pig. One data set is an original population and the other is a F3+F4+F5 generation of a line created from mating a Chato Murciano female with a Large White boar as part of an absorption programme based on backcrosses with Chato Murciano boars.

Resumen

La raza Chato Murciano es la única raza porcina superviviente de aquellas que históricamente se criaban en la región de Murcia por la calidad de su carne. Actualmente se encuentra en vía de extinción, ya que su población consta de tan solo 260 reproductores. Este artículo describe los estudios genéticos realizados para la conservación y programa de recuperación de esta raza. En primer lugar se llevó a cabo un estudio de la caracterización morfológica de estos animales, midiendo 13 variables cuantitativas y seis cualitativas en una muestra de 24 animales adultos, 8 machos y 16 hembras.

Como consecuencia, se realizó un estudio sobre la consanguinidad de los individuos y de la población, así como sobre la influencia futura de la consanguinidad en cada generación. Por fin, la exactitud y precisión del método heterocigoto-exces fue evaluada utilizando dos series de datos de la raza Chato Murciano. Una de las series de datos proviene de una población y la segunda es una generación F3+F4+F5 de una línea creada por el cruce de hembra de Chato Murciano con macho Large White como parte de un programa de absorción basado en retrocruzamientos con machos de Chato Murciano.

Keywords: Chato Murciano pig, Autochthonous breed, Morphological characterisation, Genetic studies.

Introduction

The meat industry of south-eastern Spain required an improved pig from the primitive Murcian breed in their Gabana and Pintada variations and so they were crossed with the Yorkshire, Berkshire, Tamworth, Craonés and Alderney breeds. The Gabana type has a black coat and bristles while the Pintada type also has a black coat and bristles, but which were either tawny or had spots of red or white hair (Peinado *et al.*, 2001; Poto *et al.*, 2002).

The Murcian variety's abundance of fat was reduced and the yield and proportion of lean meat improved by crossing with the Yorkshire and Berkshire breeds. The primitive Murcian pigs also benefited from the precocity and prolificacy of these two breeds, without losing their adaptability characteristics or their capacity for agricultural farming and feeding on leftover food products from the traditional canning industry of the Murcian Region. At the

beginning of the century 20th, this new breed was called the Chato Murciano (Figure 1) and spread all over the south-eastern coastal region of Spain, reaching the Catalan and Balearic coast, and was in great demand due to its precocity and lean meat (García *et al.*, 1990).

However, the pressure imposed by commercial hybrids obtained from select breeds and submitted to highly technical intensive systems, has pushed this breed aside to the point of practically eliminating it (Martínez *et al.*, 1998; Lobera, 1997). At present, the nucleus of pure breed specimens is very small, which has led the Ministry of Agriculture to declare the Chato Murciano a breed under special protection.

The Murcian Institute of Agricultural and Alimentary Research and Development (I.M.I.D.A.) and the Agricultural Training and Experiments Centre (CCEA), of the Murcian Regional Government started work some years ago on the conservation of the scarce specimens of this breed and on



Figure 1. Chato Murciano boar.

increasing the number of animals with the collaboration of a small number of stockbreeders.

As regards this first activity, semen from five male pigs of the Chato Murciano breed was frozen, and fresh semen is being used for the artificial insemination of females, not only in the CCEA, but also in private stock farms which request it, on the condition that they supply data on any animals obtained from this operation. Rotation of male pigs is taken into account when mating them with pure-breed or crossbred females, in order to keep inbreeding as low as possible. The aim of increasing the number of animals is to identify the characteristics of the Chato Murciano breed which are of most interest to the industry and which in the past provided the authentic products of the Region of Murcia.

The aims of this paper were to define the production situation of the Chato Murciano breed, defining its standard as it is today, and to investigate the genetic situation of the individuals and of the population in general, in order to undertake a recovery programme of the breed.

Materials and Methods

A total of 24 animals belonging to four different groups were used. The four groups were:

- Group 1: Three seven-month-old male pigs intended for slaughtering.
- Group 2: Four seven-month-old female pigs intended for reproduction.
- Group 3: Twelve reproductive female pigs in different reproductive conditions.
- Group 4: Five reproductive male pigs intended for the production of semen.

The variables measured for each of the animals were as follows.

Quantitative variables

- Head length: the distance between the occipital tip and the snout of the animal.

- Head width: the distance between both zygomatic arches.
- Length of the snout: the distance between the frontal nasal suture and the upper part of the snout.
- Distance between eyes: the shortest distance between the two eye sockets.
- Height at withers: the distance between the ground and the highest part of the withers.
- Breast height: the distance between the most sloping part of the withers and the most curved part of the sternum.
- Breast width: the distance between the ribs on each side using as a reference point the edges of the rib area with the front legs.
- Height of the rump: the distance between the ground and the highest point of the hip bones.
- Rump width: the distance between the external iliac tuberosities.
- Length of the rump: the distance between the beginning of the rump (external iliac tuberosity) and the end of the ischion.
- Longitudinal diameter: the distance between the ischiatic protuberance and the joint of the shoulder blade and the humerus.
- Thoracic circumference: the length of the circumference formed by the thorax around the back.
- Shank circumference: the length of the circumference of the metacarpus at the narrowest part.

Qualitative variables

Coat and hair, special features, hooves, mucous membrane, ears, number of mammary glands were observed. To study the breed's genetic situation the species/breed purity degree for all the population was determined by studying and analysing the available genealogical information and its proximity to the breed standard. Sex ratio and population age structure were determined.

Coefficient of consanguinity (Wright, 1922) for every animal in the population was calculated, and the average level of inbreeding in the population deduced, according to the average coefficient of the population consanguinity (Cavalli-Sforza and Bodmer, 1981). The expected increase in the rate of consanguinity of the population in following generations was estimated using the actual size of the population (Falconer, 1982).

Genetic molecular studies

The accuracy and precision of the heterozygote-excess method was evaluated using two data sets from the Chato Murciano pig. One of them is an original population and the other is a F3+F4+F5 generation of a line created from the mating of a Chato Murciano female with a Large White boar as part of an absorption programme based on backcrosses with Chato Murciano boars.

Eighty three animals were used for the molecular genetic identification as follows:

- 24 original Chato Murciano
- 7 Chato Murciano of unknown genealogy
- 7 Chato Murciano crossbred with other breeds (used as out-group in individual tree)
- Chato Murciano female x Large White boar for F1 (absorption of Large White influence in next generations with Chato Murciano boar):
- 1 F2 (F1 x Chato Murciano boar),
15 F3 (F2 x Chato Murciano boar),
17 F4 (F3 x Chato Murciano boar) and
12 F5 (F4 x Chato Murciano boar)

Twenty-five pig microsatellites were selected from the 27 markers published by Denis Milan and Martien Groenen (FAO, 1998). PCR amplification was performed on a GeneAmp 9600 (Perkin Elmer, Norwalk, CT, USA). Twenty-three microsatellites were amplified in seven multiplexed reactions (M1-7) and the remaining two markers in single PCR. PCR products were pooled in

three tubes as follows: M1+M2+M3+S0355, M4+M5 and M6+M7+S0386.

A MICROSAT v.1.5b computer program (Minch, 1997) was used to calculate base pair distance values from inter-individual genetic distance, based on the proportion of alleles shared by two individuals averaged over *loci* (Bowcock *et al.*, 1994). These distance values were used to construct an UPGMA tree (Sneath and Sokal, 1973) using the NEIGHBOR module of the PHYLIP v.3.57c computer package (Felsenstein, 1995) and was drawn using the TREEVIEW application (Page, 1996).

The average heterozygosity and standard deviation for each *locus* and the probability of heterozygosity excess for the original Chato Murciano group and backcrossed group under IAM (infinite allele model) and SMM (step mutation model) were estimated using the computer program BOTTLENECK (Cornuet and Luikart, 1996).

This work was part of a conservation programme to recover the breed. When a population experiences a reduction followed by an expansion of its effective size, it is said that it has suffered a bottleneck. Bottlenecked populations generally develop a heterozygosity excess at selective neutral loci (Cornuet and Luikart, 1996), *i.e.* the heterozygosity computed from some genetic markers is larger than the heterozygosity expected at mutation drift equilibrium, given the number of alleles found in the population. It is important to detect population bottlenecks in threatened and managed species because bottlenecks can increase the risk of population extinction. Early detection is critical and can be facilitated by powerful statistical monitoring programs.

Results and Discussion

A zoometric study of 13 parameters was carried out on 24 animals of this breed from which the following results were obtained. The results of the quantitative variables are summarised in table 1 and 2.

Table 1. Average zoometric measurements in three groups of pigs of the Chato Murciano breed (cm).

Variable	Group 1 N=3 X±SD	Group 2 N=4 X±SD	Group 3 N=12 X±SD
Head length	25.16±0.28	24.5±1.0	25.65±1.95
Head width	13.0±2.17	13.17±1.26	16.32±1.17
Length of the snout	8.16±1.25	7.25±0.5	8.5±1.44
Distance between eyes	9.0±0.25	8.62±0.75	11.91±1.83
Height of the withers	58.33±4.16	56.76±1.25	65.25±3.01
Rump width	29.33±1.75	25.87±1.43	33.12±2.47
Longitudinal diameter	94.83±8.40	88.5±5.30	97.75±6.07
Breast height	31.16±2.02	30.25±0.95	37.87±2.98
Breast width	28.50±1.3	27.62±3.47	31.93±2.13
Height of the rump	64.33±1.15	65.25±2.21	71.12±2.47
Rump length	27.16±0.76	28.62±3.19	28.33±2.45
Thoracic circumference	105.66±5.03	96.25±2.98	112.87±87
Shank circumference	16.66±0.76	16±0	18±1.83

Group 1: Three seven-month-old male pigs intended for food and slaughtering.

Group 2: Four seven-month-old female pigs intended for reproduction.

Group 3: Twelve reproductive female pigs in different reproductive situations.

Table 2. Zoometric measurements found in the boar of this breed (cm).

Variable	Chato viejo	Chato 222	Chato 215	Chato 802	Chato 807
Age	12 years	4.5 years	3.5 years	1.5 years	1 year
Head length	28.5	29	29	28.5	27
Head width	20	18.5	18	17.5	16
Length of the snout	9	10.5	10.5	10	9.5
Distance between eyes	16	14	16	13	12.5
Height of the withers	82.5	87	85	73	71
Rump width	37	37	36.5	39	34
Longitudinal diameter	132	124	124	118	107.5
Breast height	43	42.5	42.5	42	36
Breast width	44	37.5	37	37	34
Height of the rump	85.5	86	86	78	81
Rump length	42	36	38	34	31
Thoracic circumference	140	134	126	120	109
Shank circumference	22	22	22	19	18

Qualitative variables

Coat and hair

The breed has a black coat, characteristic of the so-called “Chato Murciano Negro” variety, which was produced in the CCEA in Lorca (Murcia). The colour is uniform except for a

few specimens which have white patches on their legs, snout and tail. The appearance of white parts is due to the characteristics inherited from the male pig of the Berkshire breed at the time of the breed formation.

The hair is a distinctive characteristic of the female pigs and is evenly distributed all

Table 3. The total population of the “Chato Murciano” according to the degree of purity, sex and age groups.

Born	Animals	Breed	Animals	Crossed
	Male	Female	Male	Female
Before 1995	2	2	0	0
1995	1	0	0	0
1996	0	8	0	6
1997	5	5	4	15
Total	8	15	4	21

over the body. The area of the mammary glands is free from hair in the female pigs.

Special features

When white colouring is found in the above mentioned areas, it not only appears on the skin, but also in the hair and on the hooves. The mucous membrane of the mouth is normally dark in colour, with the above mentioned exceptions, though it may have a whitish appearance with sections of white hair in the most closed areas.

Ears

They ears are large, triangular and point upwards and outwards.

Number of mammary glands

In the present specimens, the number of mammary glands varies between twelve and fourteen.

Genetic situation of the breed

The individual consanguinity coefficient ranged between 0% and 33.20% with an average of 10.95% calculated according to Cavalli-Sforza and Bodmer (1981). The average consanguinity of the population is found within a range of between 2.12% and

19.78%. The result of this consanguinity data can be considered alarming, as it includes some levels which exceed the limits for the appearance of inbreeding depression effects, according to Cardellino and Rovira (1987) and Legates and Warwick (1992) (Tables 3 and 4). The most immediate consequences of the inbreeding depression are the loss of adaptive values (productive and reproductive) as well as the appearance of the expression of deleterious genes in the population.

A cautionary note is that this figure only indicates the accumulated levels of inbreeding from the genetic information available, and as this breed has recovered from a small number of animals, it is possible that the rate of consanguinity prior to the genealogical check was high. For this reason, higher rates of underlying inbreeding are to be suspected, which would explain the fertility problems, the reduced number of piglets per litter, and the low viability of the piglets and the lack of hardiness in crossbreds (reduction of the body size) as consequences of the inbreeding depression.

Allelic frequencies for original and backcrossed groups are presented in table 5, only some exclusive alleles were found in each population with low frequency. Also the tree of genetic distances shows a mixture of individuals from two cited groups (Figure 2). Therefore the effect of the crossbreeding with a Large White individual seems to be absorbed after three backcross generations.

For both mutation models, IAM and SMM, the original population of Chato

Table 4. Average level of population consanguinity, according to Cavalli-Sforza and Bodmer (1981).

No. of animals	Relative frequency (P_i)	Consanguinity Coef. (F_i)	$P_i \times F_i$
26 (11 ^a)	0.541	0.0000	0.000000
01 (01 ^a)	0.021	0.1250	0.002625
08 (08 ^a)	0.167	0.1568	0.026177
04 (2 ^a)	0.083	0.2500	0.020750
06	0.125	0.3125	0.039062
03 (03 ^a)	0.063	0.3320	0.020916
Total			0.109530

(*) Crossed animals in absorption process.

Table 5. Allele frequencies in pure and crossbred Chato Murciano pigs.

Marker	# alleles	Frequencies in decreasing order					
CGA	6	0.68056	0.13889	0.11806	0.03472	<i>0.00694</i>	<i>0.02083</i>
S0101	3	0.51852	0.27778	0.20370			
S0215	1	1					
S0355	2	0.78659	0.21341				
SW911	5	0.50000	0.27778	0.17284	0.04321	<i>0.00617</i>	
SW936	6	0.32927	0.26829	0.17073	0.14634	0.07927	0.00610
S0068	5	0.50625	0.26875	0.10000	0.09375	0.03125	
SW632	4	0.70139	0.18056	0.11111	0.00694		
SW24	4	0.90845	0.03521	0.02113	0.03521		
S0227	2	0.88889	0.11111				
S0225	3	0.65000	0.23125	0.11875			
SW122	3	0.63971	0.33088	<i>0.02941</i>			
S0090	5	0.39103	0.30769	0.23718	<i>0.05769</i>	0.00641	
S0226	3	0.72222	0.17284	0.10494			
SW591	2	0.93210	0.06790				
S0228	2	0.59028	0.41171				
S0178	4	0.49242	0.33333	<i>0.12879</i>	0.04545		
S0005	5	0.26875	0.37500	0.33750	0.01250	<i>0.00625</i>	
S0386	4	0.48000	0.29333	0.15333	0.07333		
SW72	5	0.64557	0.25949	0.08861	0.00633		
S0002	3	0.69178	0.15068	0.15753			
SW857	4	0.65234	0.219.51	0.05488	0.07317		
S0026	4	0.60638	0.20213	0.14894	<i>0.04255</i>		
IGF1	4	0.51235	0.33333	0.14198	<i>0.01235</i>		
S0155	4	0.61585	0.31707	0.06098	<i>0.00610</i>		
SW240	2	0.56707	0.43293				

Notes: Exclusive alleles of the original population of Chatos are in bold.

Exclusive alleles of the F3+F4+F5 are in italic.

Murciano does not show heterozygosity excess, rejecting the hypothesis of a recent bottleneck (Table 6). Nevertheless the backcrossed group showed heterozygosity

excess rejecting the drift equilibrium. This result was expected because all the individuals descend from one male and one female.

Table 6. Results of the application of both mutation models, IAM and SMM, on pure and cross-breed Chato Murciano animals.

Mutation model		Original	F3+F4+F5
IAM ¹	Expected markers with excess heterozygosity	12.8	12.62
	Markers with deficiency of heterozygosity	9	3
	Markers with excess heterozygosity	14	21
	Probability of mutation effect / bottleneck ³	0.2905	0.0003
SMM ²	Expected markers with excess heterozygosity	13.07	13.54
	Markers with deficiency of heterozygosity	11	6
	Markers with excess of heterozygosity	12	18
	Probability of mutation effect / bottleneck ³	0.4013	0.0482

Note:

1. "Infinite Allele Model"
2. "Step Mutation Model"
3. $P < 0.05$ reject the hypothesis of mutation drift equilibrium suggesting a recent reduction in population size

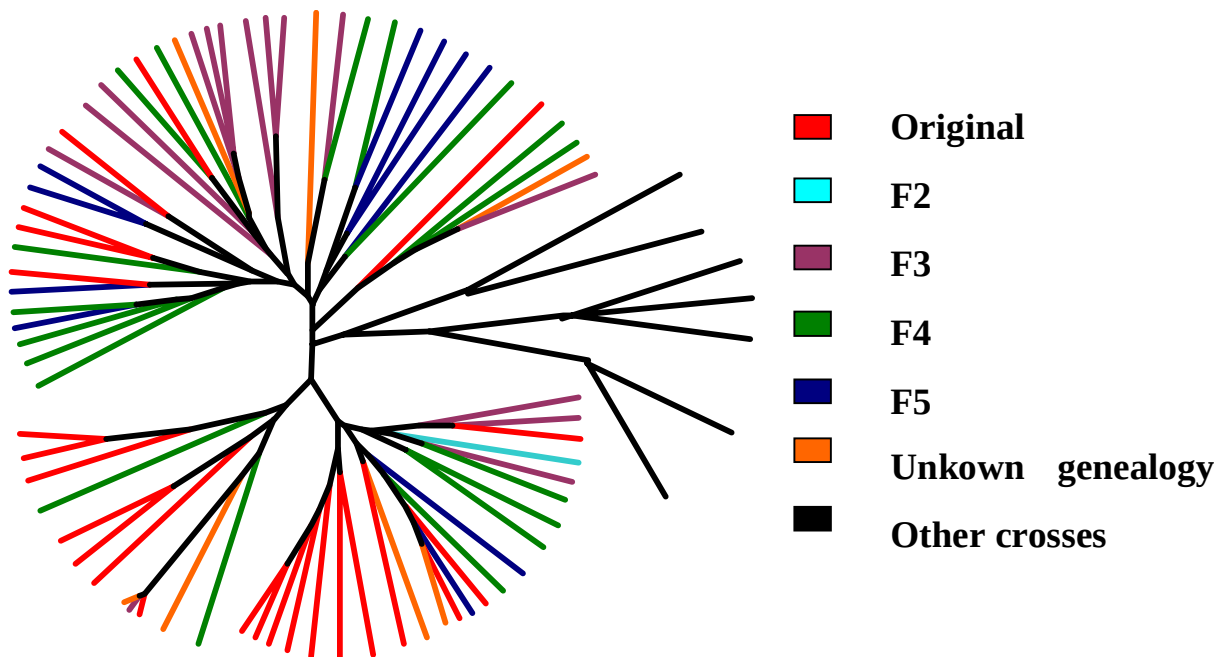


Figure 2. Individual tree UPGMA method.

Conclusions

For future measures a strict genealogical and reproductive control must be followed, by making a guided mating system compulsory. Use is being made of the tables of co-ancestry in order to determine the expected increase of consanguinity in future litters, and to minimize it. Furthermore, as a complementary measure, the Genetic Conservation Index (Alderson, 1992) can also be used, so that the variability in the breed is maximized, whilst the increase in consanguinity is minimized.

Allelic frequencies and genetic distances show minimum differences between original and backcrossed groups; therefore it is possible to establish a conservation plan based on absorption crosses to reduce inbreeding problems in enlarged populations.

There is an opportunity to recover the Chato Murciano breed because it shows some variability and does not show a strong allelic reduction and disequilibrium of genetic frequencies.

The use of an external reproducer in the first steps is a very good tool to increase the size of a population in exceptional cases because its influence can be absorbed in a few generations.

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L'élevage porcin au Tchad: Bilan de l'introduction, de l'amélioration et de la diffusion des races exotiques

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Résumé

Le porc local d'origine ibérique a été introduit au Tchad en 1918, par des missionnaires en provenance du Cameroun. Ensuite en 1951, le porc limousin originaire de France fut importé par le service de l'élevage afin d'améliorer le format et le rendement du porc local. Après quatre années d'essais, ce programme a été abandonné au Nord, essentiellement pour des raisons religieuses. En revanche, dans la partie sud majoritairement non musulmane, la diffusion a enregistré un succès relatif jusqu'en 1958. Par la suite, des géniteurs de la race Yorkshire et Berkshire furent importés du Moyen Congo. Quelques élevages «semi-industriels», installés dans les années 1950 et aux mains des expatriés, ont adopté ces races et ont contribué à l'exportation de viande dans la sous-région de l'Afrique Equatoriale française (AEF). Les traditions d'élevage des populations locales, l'appui des services agricoles et des sociétés de développement (Paysannats et Communautés villageoises) de la région ont contribué au succès relatif de cette diffusion. En outre, l'absence des relevés zootechniques précis, n'a pas permis d'apprécier les performances de ces races et des méti. L'alimentation, le gardiennage défectueux et le manque de déboucher pour la production paysanne ont été des obstacles majeurs au développement et à la vulgarisation de l'élevage porcin en milieu paysan.

Summary

The local pig from Iberian peninsula was introduced to Chad in 1918 by missionaries arriving from Cameroon. In 1951, the Limousine breed from France was introduced by artificial insemination in order to improve the conformation and meat yield of the local pig. After five years of trials, the program failed in the northern part of the country for religious reasons. Nevertheless, in the southern region, which is mostly non-Muslim, the expansion achieved relative success until 1958. In addition, breeding stocks of Yorkshire and Berkshire pigs were imported from the middle Congo. A few semi-industrial farms, established in the 1950, adopted these breeds and have contributed to the export of meat in the sub-region of French Equatorial Africa. In its expansion the pig farming traditions have been supported by agricultural services and development societies (peasantries and village communities). Moreover, the lack of precise technical data on the performance records did not permit the evaluation of the performances of these breeds and crossbreeds. Feed issues, faulty herding and a lack of access to markets have been the major obstacles to the expansion and popularization of pig farming in rural areas.

Mots clés: Élevage porcin, Introduction, Amélioration, Diffusion, Tchad.

Introduction

L'estimation basée sur un taux annuel de croît de 5%, donnait un effectif porcin (très largement en deçà de la réalité) au Tchad de 63.500 têtes en 1997 (Abba *et al.*, 1997). Dans les années 1950, le Tchad a été exportateur de viande porcine dans plusieurs pays de l'Afrique Équatoriale française (AEF). La production porcine s'est développée dans des élevages privés semi-industriels de Fort-Lamy (devenu N'Djaména) et de Massakory dans le Chari-Baguirmi, dans les centres zootechniques administratifs de NGouri (Kanem), d'Abougoudam (Ouaddaï) et surtout de Fianga dans le Mayo-Kebbi et en milieu paysan (Figure 1). Des travaux récents ont mis en évidence l'existence depuis 1990, d'une filière d'exportation de porcs sur pieds vers le Cameroun (Koussou, 1999).

L'existence de ce débouché favorise le développement de l'élevage porcin, 65 à 70% des élevages ayant été mis en place après 1990 (Mopate, 2000; Sana, 1997). Ces résultats tendent à confirmer une reprise de l'élevage traditionnel du porc, dont le bassin de production se situe en zone soudanienne.

Cette synthèse vise une meilleure connaissance de l'histoire de la filière porcine au Tchad afin de répondre à un certain nombre des questions sur l'introduction, l'amélioration et la diffusion des races exotiques. La nature des éleveurs, les modes de conduite, les contraintes et les atouts de cet élevage sont également abordés en ordre chronologique.

Les aptitudes et les performances zootechniques des races utilisées (en France) sont rapportées afin de pouvoir les comparer. Des données de reproduction, issues d'études menées récemment en zone soudanienne du Tchad et à N'Djaména, permettent d'apprécier les performances des porcs locaux (Figure 2; Figure 3), lointains descendants d'animaux de races exotiques, dans les conditions précaires d'élevage.

Résultats et Analyse

Introduction du porc dans la colonie du Tchad

En 1918 des porcs ont été introduits dans le Sud du Tchad en grande quantité, à partir du Cameroun par des missionnaires (Aef, 1921; Zeuh, 1997). Il semble que ces porcs étaient issus d'un croisement entre la race "Deutsche Landschwein" et la race locale des régions côtières du Golfe de Guinée, cette dernière dérivant de la race ibérique. Pour le Service colonial de l'élevage de l'époque, il était possible de développer un élevage porcin en pays fétichiste (vocabulaire employé pour désigner les populations animistes du sud du Tchad), quoique la sensibilité de l'animal à la trypanosomose soit susceptible d'entraver son développement (Aef, 1921).

Evolution des essais d'amélioration et de diffusion des races porcines

Quelques tentatives d'amélioration par des géniteurs de race limousine ont eu lieu dans les établissements zootechniques du service de l'élevage et de Industries Animales du Tchad. Ces essais dont l'objectif était d'améliorer le format et le rendement du porc local, puis sa diffusion en milieu paysan ont démarré en 1951 dans les fermes d'Abougoudam, de Ngouri et de Fianga (Aef, 1952). A Abougoudam, l'élevage a démarré avec 11 géniteurs. Après un an, quatre produits (2 mâles et 2 femelles) ont été cédés gratuitement à des particuliers dans la ville d'Abéché. Les géniteurs étaient maintenus en claustration jusqu'à l'élimination des porcs communs, avant de leur laisser une certaine liberté de mouvement (Aef, 1951). A Ngouri, l'élevage du porc avait un caractère accessoire, les animaux améliorés se retrouvant là-bas afin de répartir les risques. Cette ferme manquait de personnel, de locaux spécialement aménagés et l'alimentation était constituée des refus des

chevaux et de légumes. Ces conditions précaires ont été à l'origine des pertes importantes en particulier de jeunes. Néanmoins, sur 92 porcs recensés en fin 1952 dans les trois fermes d'élevage, 39 furent vendus aux particuliers. A la fin de l'année 1952, il était prévu de créer d'importants élevages porcins dans les zones rizicoles afin de profiter des sous-produits de rizeries non valorisés (Aef, 1952). Les concepteurs du projet prévoyaient la possibilité d'une production de porcs à faible coût et d'exportation de la viande vers les pays côtiers.

En 1953, l'effectif porcin de la ferme d'Abougoudam était réduit à 18 animaux, à cause du dépôt de bilan de la société exportatrice de viande à l'origine de la promotion de cet élevage. Seuls quelques reproducteurs y étaient entretenus. La fermeture de cet élevage était sérieusement envisagée, pour ce problème auquel se greffait l'hostilité des populations locales

musulmanes vis à vis du porc. En revanche, à Fianga, l'élevage porcin se portait bien. Il n'existait pas d'interdit sur le porc, et on trouvait du riz paddy en abondance dans la zone. Les effectifs porcins à Fianga étaient de 47 Limousins et 11 Locaux. Au cours de la même année, 29 naissances et 18 mortalités étaient enregistrées. Vingt neuf animaux, dont 23 porcs de race locale et 6 Limousins, étaient cédés à des paysans sélectionnés. En 1954, un large programme de cession gratuite était envisagé. A Ngouri, les effectifs passaient de 35 au début de l'année à 18 à la fin de l'année, après 21 distributions et quelques cas de mortalité. Les résultats d'essais menés dans les fermes d'élevage montrèrent que les femelles de race limousine produisaient moins de lait que les femelles issues des croisements (Aef, 1953). En conséquence, on distribuera des verrats limousins pur-sang et les métisses de la première génération (F1) aux particuliers et aux Paysannats (vocabulaire utilisé pour désigner les groupements paysans à l'époque).

Cette méthode permettrait de produire des porcs 3/4 de sang dans d'excellentes conditions. Ils atteignaient 70 kg en huit mois, alors que le porc de race local n'arrivait à ce poids qu'au bout de 16 mois. Le succès de l'opération a entraîné une augmentation des commandes en reproducteurs et 500 porcs 3/4 de sang furent produits en 1953.

En 1954, c'est la fermeture officielle de l'élevage de Ngouri, après la distribution de 52 reproducteurs en quatre années d'existence. Selon le rapport du service de l'élevage, ces reproducteurs ont été à la base des élevages tenus par des européens, notamment celui de Mr. Chantaloup, à Massakory (à 150 km au Nord de Fort-Lamy) et de MM. Taransaud et Cabrini à Fort-Lamy (Aef, 1954). A la fermeture de l'élevage de Massakory en 1964, les porcs abandonnés à eux-mêmes ont survécu tout de même jusqu'à la fin des années 70. Les animaux restant de la ferme de Ngouri furent transférés à la ferme de Fianga, où trois troupeaux porcins (un Limousin, un local et un métis) étaient entretenus. Un programme

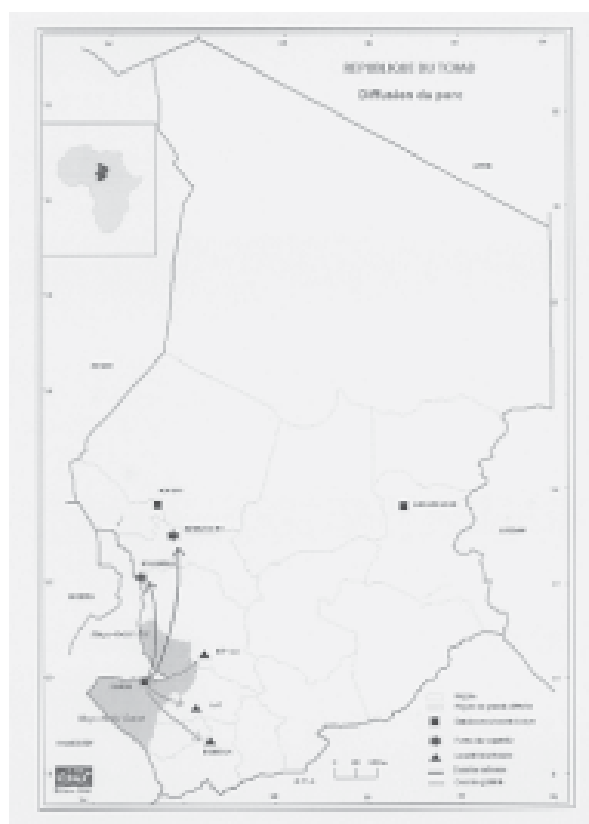


Figure 1. Diffusion du porc au Tchad.



Figure 2. Porcs aux robes variées prenant un bain aux abords d'un ouvrage hydraulique villageois au sud du Tchad.

de conduite au pâturage le matin et de distribution d'une ration alimentaire le soir était mis en place, afin d'être diffusé en milieu paysan. Dans la même année, 84 animaux dont 65 Limousins et 19 Locaux ont ainsi été distribués.

Implanté dans des régions à fortes dominance musulmane, trop éloignées des centres de consommation potentiels, les élevages porcins de Ngouri et d'Abougoudam ont cessé leurs activités quatre années après leur installation.

En 1955, Fianga restait le seul établissement zootechnique où des porcs étaient entretenus. Des observations zootechniques sur une taille moyenne de portée de 7,2 (dont 3,4 mâles et 3,8 femelles), sans précision sur la race concernée, ont été rapportées (Aef, 1955). Les animaux reproducteurs devant faire parti de la ferme étaient sélectionnés sur des critères de fécondité et des caractères phénotypiques peu précis. Des distributions gratuites de 101 animaux (dont 81 Limousins, 14 de race locale et 6 métis) ont été réalisées dans les cantons de Fianga (Youé et Fianga) et de Gounou-Gaya (Gounou et Tagal) dans le

Mayo-Kebbi. Six villages dans le Canton Gounou et quatre dans celui de Tagal ont été concernés. La ferme du Collège d'Enseignement Agricole de Ba Illi (Chari-Baguirmi) et la station de l'Institut de recherche cotonnière et de textile (IRCT) de Bébédja (Logone Oriental) en ont également reçu (Aef, 1955). En milieu paysan, les porcs étaient logés dans des enclos en banco. Ils étaient lâchés dans la matinée et allaient dans des bas-fonds où des mares environnantes à la recherche de la verdure et l'eau. La complémentarité se résumait à du son de céréales et à des restes de repas. En période de culture, les enfants assuraient le gardiennage. Le bon comportement de ces géniteurs en milieu paysan avait suscité plusieurs demandes d'acquisition notamment de la part des missions catholiques. Celles-ci promettaient de construire des porcheries avec des matériaux locaux. Avec la réussite de ce programme, les responsables envisageaient une diffusion à plus grande échelle des géniteurs et un appui aux éleveurs pour la commercialisation des produits. Une condition préalable était l'engagement de la Société africaine de

prévoyance (Sap), pour la constitution des stocks de son de paddy et du Service agricole pour la construction des porcheries en matériaux locaux dans les paysannats.

En 1956, le programme de travail de la ferme de Fianga faisait mention d'un contrôle zootechnique visant à préciser la conformation et la reproduction des porcs. Des travaux étaient également menés sur la castration des mâles métis et les techniques de vulgarisation (Aef, 1956). Ce suivi zootechnique s'est avéré par la suite difficile à cause du mélange des animaux au pâturage et dans la piscine au moment des chaleurs. Environ 167 porcs ont été cédés gratuitement dont 67 de race limousine, 79 métis et 21 de race locale. Les bénéficiaires étaient les éleveurs locaux avec 99 porcs, les fermes agricoles et les Paysannats (32 animaux), l'IRCT de Tikem (8 animaux), les missions catholiques (6 autres) et, à titre onéreux, les bouchers de Fort-Lamy avec 22 têtes. Le principal problème était la commercialisation des produits de cet élevage qui se posait depuis son implantation

en milieu paysan. De sa résolution semblait dépendre la réussite totale de ce programme, celui-ci faisant du Mayo-Kebbi une grande région d'élevage porcin. Les réticences observées parfois du fait des dégâts occasionnés aux cultures, pouvaient être vaincues par la sensibilisation et la persuasion. Les arguments développés pour inciter les paysans à la pratique de l'élevage porcin étaient fondés sur la nécessité de diversifier ses activités de production et la prolificité exceptionnelle de cette espèce. Les slogans de sensibilisation étaient les suivants: *"la culture attelée du mil et du coton n'est pas tout pour le producteur. Il faut d'autres sources de revenus que le coton, qui ne se commercialise qu'une seule fois dans l'année. Une vache donne un veau tous les deux ans, alors qu'une truie donne quatre portées de sept porcelets chacune pendant la même période. Les occasions de vente et de consommation de la viande sont multiples pour un éleveur de porcs"*.

L'année 1957 a constitué un tournant décisif avec la remise en cause du programme de diffusion et de vulgarisation



Figure 3. Porcs en divagation dans une rue de N'Djaména en saison de pluies.

du porc limousin au Tchad. Selon Aef (1957), les justifications étaient la qualité moyenne des troupeaux, le manque de précocité du Limousin en race pure, sa tendance à prendre plus du gras à l'âge adulte, la médiocrité sur le plan de la charcuterie (race peu appréciée par l'industrie), le format médiocre du métis et son manque de rusticité par rapport au limousin pur. Le manque de motivation des éleveurs était également évoqué. Deux possibilités furent envisagées : continuer l'élevage des Limousins en race pure, ou alors s'orienter vers d'autres races notamment le Large White (appelé aussi Yorkshire), le Middle-White ou le Berkshire. Il était proposé de recentrer les activités vers la production des porcs de qualité, pour l'approvisionnement des centres urbains tels que Fort-Lamy. Les cessions ont porté au cours de l'année sur 83 métis et 79 Limousins.

En 1958, les décisions de réforme des troupeaux porcins (limousins et de croisement) et d'introduction d'autres races furent appliquées. Dans ce cadre, 249 porcs dont 177 Limousins et 72 métis, ont été cédés gratuitement ou vendus aux Sap et aux paysannats de la région. Pendant la même année, 5 géniteurs Berkshire (3 femelles et 2 mâles), 11 Yorkshire (8 femelles et 3 mâles) et une femelle croisée Berkshire x Yorkshire ont été importés du Moyen Congo, actuel République Démocratique du Congo-RDC (Ministère de l'Élevage, 1958).

On enregistra 334 porcelets nés entre 1959 et 1961 (Tableau 1), dont environ 81% de race Yorkshire. Mais les pertes importantes

(45%) chez les jeunes pendant cette période, dues à la mauvaise qualité de l'eau de la piscine, à la prédation par les Chacals et l'écrasement par les mères ont contribué à relativiser ce succès.

Malgré tout, une cession de 86 animaux a été réalisée entre 1960 et 1961 (Ministère de l'Élevage, 1960 et 1961). Les bénéficiaires étaient le paysannat de Daoua, la communauté villageoise de Tikem et celle du canton de Fianga. En 1961, 6 géniteurs sont allés à la rizerie de Lai comme prévu en 1960. Ces bénéficiaires répondaient aux critères de sélection des villages et des paysannats établis par la ferme, pour plus d'efficacité. Elle exigeait la présence des pâturages verts et d'eau en abondance toute l'année et la construction préalable d'une porcherie. Les mauvais résultats enregistrés en 1959 et le manque d'intérêt des paysans ont conduit les responsables à changer de politique. Elle consistait à motiver les paysans par la sensibilisation et un encadrement technique. L'idée de développer un élevage commercial rentable, préconisée en 1957, fut remise en cause, et on s'est orienté vers la vulgarisation et la diffusion des nouvelles races (Yorkshire et Berkshire) en milieu paysan. En 1960, les animaux conduits en troupeau séparé, pâturaient librement des parcelles de mil hâtif à maturité et recevaient en *self-feeding* un complément composé de farine de riz (Rizerie de Yagoua localité camerounaise, proche de Fianga), de mil concassé, de tourteau d'arachide, de poudre d'os, de sel et de chaux (Ministère de l'Élevage, 1960). En 1961, 40 femelles de

Tableau 1. Evolution des naissances et des mortalités dans les troupeaux Yorkshire et Berkshire à la ferme de Fianga entre 1959 et 1961.

Année	Naissance		Mortalité	
	Yorkshire	Berkshire	Yorkshire	Berkshire
1959	57	-	11	05
1960	103	-	60	02
1961	112	62	64	07
Total	272	62	135	14

Source: Ministère de l'Elevage, 1959; 1960 et 1961.

deux races (Yorkshire, Berkshire) furent vendues à la ferme « semi-industrielle » de Massakory pour le renouvellement de son cheptel.

Selon le rapport du Ministère de l'Élevage (1961), la plus grande partie des animaux ont été cédés dans la zone de Fianga, Pala et Gounou-Gaya. L'introduction, l'acclimatation et la diffusion des Limousins, Yorkshires et Berkshires avaient relativement été un succès dans ces zones malgré la forte mortalité observée chez les jeunes (Yorkshires). La même source faisait état d'importantes recettes provenant de la vente contrôlée (68 porcs d'un poids moyen de 86 kg rapporta 456 000 F CFA à 21 membres du paysannat du canton Torrock). En outre, plusieurs ventes des reproductrices avaient également été observées entre cultivateurs, afin de créer des élevages dans d'autres cantons et villages de cette localité. Le travail de vulgarisation et d'encadrement entrepris par la ferme commençait à porter ses fruits.

Ce succès a été relativisé car les objectifs de départ qui étaient d'améliorer le format et le rendement du porc local, puis sa diffusion en milieu paysan n'avaient pas véritablement été atteints selon un rapport du Ministère de l'agriculture et de la production animale - Mapa- (1964). Les paysans se préoccupaient peu de l'alimentation et du gardiennage des animaux. D'autre part l'importation des Yorkshires et Berkshires n'a pas suscité d'intérêt particulier parmi les éleveurs, ceux-ci préféraient le porc limousin, plus rustique et plus proche des porcs locaux. Néanmoins, pour Mapa (1964) l'opération d'amélioration avait permis de fournir aux collectivités locales qui possédaient déjà des animaux, des métis plus intéressants sur le plan de la conformation et un appoint alimentaire aux paysans. Au total 1 134 porcs toutes races confondues ont fait l'objet des cessions (Tableau 2) durant cette période. Les cessions de 1958 ont été élevées à cause de la liquidation des animaux de la race Limousine. La dizaine des limousins entretenue en race pure à la ferme du Collège d'Enseignement Agricole de Ba Illi a

été décimée dans les années 80 à la faveur des événements survenus au Tchad. Bloquée au Nord et à l'Est par l'islam, la diffusion du porc en zone soudanienne a été rendue possible grâce aux efforts déployés à la ferme de Fianga (Figure 1).

Bilan de l'élevage semi-industriel de Chantaloup à Massakory

Le seul élevage «semi-industriel» qui a connu essor appréciable est celui implanté à Massakory par les établissements Chantaloup. Cet élevage avait de temps en temps eu recours aux importations de porcelets Large White du Nigeria (600 au total) pour renforcer ses effectifs. Il a approvisionné la ville de Fort-Lamy (actuellement N'Djaména) en viande de porc. L'entreprise a exporté régulièrement jusqu'en 1963 (Tableau 3) de la viande vers le Gabon, le Congo Brazzaville, la République Centrafricaine, la République Démocratique du Congo et le Cameroun. Les reproducteurs utilisés étaient des Limousins et des Large White. Le taux d'exploitation moyen était de 52% et le poids moyen variait entre 71 et 127 kg. Sous réserve des coûts de production actuels qui influent sur la vente, cet exemple montre qu'il est encore possible de monter au Tchad un élevage de type semi-industriel avec des porcs de races européennes.

D'autres élevages «semi-industriels» de moindre importance tels que ceux mis en place par Taransaud et Cabrini dans les environs de N'Djaména, ont contribué à la dissémination des porcs de races exotiques. L'élevage des porcs a toujours été pratiqué par les populations non islamisées originaires du sud du pays de cette ville. Cet élevage connaît actuellement un développement important en particulier dans les zones périurbaines sud et nord de la ville, à cause de la demande en viande porcine.

Tableau 2. Bilan de l'évolution des effectifs et des cessions des différentes races porcines à la ferme de Fiangà au Tchad.

Année	Locaux			Metis limousins			Limousins			Yorkshire			Berkshire		
	Effectifs	Cessions		Effectifs	Cessions		Effectifs	Cessions		Effectifs	Cessions		Effectifs	Cessions	
1951	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-
1952	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1953	-	23	-	-	-	-	47	6	-	-	-	-	-	-	-
1954	5	19	-	17	-	-	65	64	-	-	-	-	-	-	-
1955	23	14	-	126	6	-	35	81	-	-	-	-	-	-	-
1956	-	21	-	58	79	-	59	67	-	-	-	-	-	-	-
1957	-	-	-	52	83	-	55	79	-	-	-	-	-	-	-
1958	-	-	-	-	72	-	-	177 ¹	-	12 ²	-	-	5 ²	-	-
1959	-	-	-	-	-	-	-	-	-	58	-	-	15	-	-
1960	-	-	-	-	-	-	-	-	-	76	25	-	17	4	-
1961	-	-	-	-	-	-	-	-	-	83	51	-	66	6	-
1962	-	-	-	-	-	-	-	-	-	30	100	-	22	97	-
1963	-	-	-	-	-	-	-	-	-	21	29	-	11	19	-
1964	-	-	-	-	-	-	-	-	-	58	5	-	23	7	-
Total	28	77	-	253	240	-	272	474	-	338	210	-	159	133	-
% des cessions		7			21			41			19			12	

¹ Arrêt de l'élevage du porc limousin par cession de la totalité des effectifs.² Importation du Congo des Yorkshires et des Berkshires en remplacement des Limousins.

Source: Rapport annuel du Ministère de l'agriculture et de la production animale, 1964, modifié.

Aptitudes et performances actuelles des races Limousines, Ibérique et Large White

Les chiffres avancés ici proviennent d'élevages européens modernes. Ils ne correspondent donc pas aux performances des animaux introduits il y a 40 ans au Tchad mais permettent néanmoins de se faire une idée de la productivité de ces races.

Le limousin (race locale française)

Ce porc appartient au groupe des races «rustique» qui se caractérisent par une bonne adaptation à un milieu difficile et/ou à un mode d'élevage particulier (Sellier, 1986). Le Limousin a un faible niveau de performances (reproduction, croissance ou teneur en viande de la carcasse). Labroue *et al.* (2000) rapporte une vitesse de croissance, une efficacité alimentaire et une adiposité de la carcasse moindre du Limousin par rapport au Large White. Si Anonyme (1992) s'accorde avec Sellier (1986) et Labroue *et al.* (2000) sur la rusticité, la croissance lente et la qualité de la carcasse de cet animal, il reconnaît en revanche, à ce porc, une bonne prolificité (10 porcelets/portée) et une bonne

qualité laitière de la truie. Selon Anonyme (1992), le Limousin pèse entre 170 à 230 kg à 18 mois et a un gain moyen quotidien (GMQ) de 600g/j entre 25 et 125 kg.

Le porc ibérique (présent en milieu méditerranéen)

Il appartient au groupe des races rustiques et répond aux mêmes caractéristiques que le Limousin, notamment une bonne adaptation à un milieu difficile, un faible niveau de performances etc.

Le large White (ou Yorkshire)

Originaire du Comté de Yorkshire, dans le Nord-Est de l'Angleterre, il appartient au groupe des races mixtes (Sellier, 1986). Il bénéficie de bonnes facultés d'adaptation et des membres solides qui en font un type génétique pouvant être exploité dans des conditions diversifiées (Anonyme, 1992). En matière de performances, Sellier (1986) rapporte que les races mixtes se caractérisent par un niveau proche de la moyenne de l'ensemble des races pour la reproduction et pour la plupart des caractères de production.

Tableau 3. Évolution des effectifs, des cessions onéreuses, des tonnages de viande et de poids moyens de porcs selon les années (élevage semi-industriel de Chantaloup à Massakory) au Tchad.

Année	Effectif	Cession	Tonnage en viande	Poids moyen
1953	450	-	20 000	-
1954	560	390	28 750	71 7
1955	350	471	48 860	103 7
1956	336	410	41 500	101 2
1957	680	458	43 700	95 4
1958	1 081	450	53 172	118 1
1959	932	954	121 158	127
1960	886	-	80 000	-
1961	630	628	67 000	106 7
1962	753	-	65 000	-
1963	600	-	60 000	-
Total	7 258	3 761	629 140	

Source: Rapport annuel du Ministère de l'agriculture et de la production animale, 1964, modifié.

Les performances moyennes de reproduction des races mixtes sont de 10 à 11 porcelets nés vivants/portée, 8,5 à 9,5 porcelets sevrés/portée et entre 18 à 21 porcelets sevrés/an/truie (productivité numérique). Les performances de croissance et de consommation d'aliments en station sont, respectivement, de 800 à 900 g/j et de 2,6 à 3 kg d'aliment par kg de gain de poids entre 25 à 100 kg. Anonyme (1992) rapporte les performances de reproduction qui suivent: 11,5 porcelets à la naissance, intervalle entre mise-bas de 1153 jours, intervalle sevrage, saillie fécondante de 11,4 jours. Quant aux paramètres de production, le GMQ serait de 936 g/jour et l'indice de consommation de 2,41.

Performances de reproduction de quelques élevages en zone soudanienne du Tchad et à N'Djaména

Les performances de reproduction observées (Tableau 4) sur deux terroirs villageois du Mayo-Kebbi et du Logone Occidental en zone soudanienne (Mopate, 2000) et celles en zone urbaine de N'Djaména (Mopate et Djoret, 2001) sont faibles, comparées à celles des races exotiques précitées (Limousin et Large White).

En milieu rural, les mauvaises conditions d'élevage, notamment l'absence de porcherie,

une mauvaise alimentation, une mise au piquet en période de culture limitant la monte des femelles et la divagation à la fin des récoltes sont responsables de ces faibles performances. En revanche en milieu urbain de la ville de N'Djaména, où les conditions d'élevage sont quelque peu améliorées, ces paramètres sont meilleurs. Ces résultats sont conformes aux observations de Lebroue *et al.* (2000) sur cinq (5) races locales françaises (y compris le Limousin), selon lesquelles l'amélioration de la taille de portée peut venir de la conduite.

La vente des porcs fournie aux agro-éleveurs de cette zone les moyens financiers pouvant leur permettre l'achat des céréales après des campagnes déficitaires, le règlement des frais de scolarité des enfants ou une capitalisation vers les bovins. Les porcs sont également abattus lors des funérailles, des rituels et des travaux champêtres notamment lors du sarclage et de la récolte des céréales ou du coton. La carcasse est découpée en morceaux, puis distribués aux paysans. Parfois, c'est l'animal sur pied qui est livré à des groupes de personnes volontaires pour accomplir ces tâches.

Conclusion

L'historique de l'élevage porcin au Tchad montre que les animaux actuels sont issus

Tableau 4. Performances moyennes de reproduction comparées des élevages porcins extensifs (ruraux) et semi-intensifs (urbains) au Tchad.

Paramètres de reproduction	Semi-Intensif (Urbain)	Extensif (Rural)
Age (mois) 1 ^{ère} mise-bas	10,9 ± 2,3	11,76 ± 0,8
Age (mois) 1 ^{ère} gestation	7	8
Nbre mise-bas / an	2,0 ± 0,4	1,8 ± 0,9
Taille de portée	8,2 ± 2,3	7,2 ± 2,1
Portée né-vivant	7,1 ± 2,1	5,8 ± 1,9
Mort-nés	1,4 ± 1,2	1,6 ± 1,0
Portée sevrée	6,6 ± 2,1	5,3 ± 1,7
Age sevrage	3,9 ± 1,1	3,5 ± 1,0
Avortement	1,6 ± 1,0 (n = 24)	1,3 ± 0,8 (n = 6)

d'un croisement entre la race locale d'origine ibérique et des animaux de races exotiques. Le Limousin en race pure ou des produits issus du croisement du Limousin avec le porc local ont d'abord été utilisés. Ensuite, les races Yorkshire (ou Large White) et Berkshire ont été importées. La qualité des relevés zootechniques de l'époque ne nous ont pas permis d'apprécier les performances des races introduites et des produits issus de leur croisement avec la race locale. Une tradition d'élevage et de consommation de porcs en zone soudanienne, le soutien de l'administration territoriale, des services agricoles, des organismes de développement et l'effort de sensibilisation ont contribué à la diffusion du porc dans la partie méridionale du pays. Cependant, les conditions d'élevage n'ont pas permis à ces animaux d'exprimer leur potentiel de production. Des nombreuses contraintes techniques et organisationnelles s'opposent au développement de cet élevage. Des voies et moyens sont à explorer en vue d'améliorer la productivité des porcs locaux, pour répondre à la demande croissante en viande porcine provenant des grands centres urbains de consommation située en zone sud du pays, à N'Djaména mais également du Sud-Cameroun.

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Good Practices for the Meat Industry
Published by FAO, Animal Production and Health
Via delle Terme di Caracalla Rome, Italy
Published in 2004, pp. 210
ISBN: 92-5-105146-1; ISBN: 1810-1119

In recent years, public concern about the safety of foods of animal origin has heightened due to problems that have arisen with BSE, as well as with outbreaks of food borne bacterial infections, and food contamination with toxic agents (e.g. dioxin). These problems have serious implications for national food safety, the development of the animal products industry and for international trade in livestock products. The purpose of this manual is to provide updated comprehensive information and practical guidelines for the implementation of the new Code of hygienic practice for meat, when adopted by the Codex Alimentarius Commission.

The FAO/WHO Codex Alimentarius Commission is in the final stages of negotiation of a new Code of hygienic practice for meat. The Code implies a transition from meat inspection towards a risk-based approach covering the entire food chain.

Section 1 of the manual deals with the application of risk analysis principles to the meat sector starting from the point of production, i.e. in the animal population from which the meat is sourced. Standards and practices in primary production are covered in Section 2. Section 3 covers animal identification and Section 4 product traceability.

The following section (5) focuses on transport of animals to the slaughter facilities, duly taking into account growing animal welfare considerations. This is followed by Sections 6, 7, 8 and 9 on ante-mortem inspection; preslaughter handling, stunning and slaughter methods; post-mortem examination; and hygiene,



dressing and carcass handling. The sections on stunning and slaughter methods benefit from the experience gained in the reduction of the risk of BSE. Those on ante- and post-mortem inspection are built on the substantial historical experience of the global meat sector, and are largely documented from FAO resources.

There are sections on design, facilities and equipment (10) and personal hygiene (11). Section 12 of the manual describes the implementation of a Hazard Analysis and Critical Control Point (HACCP) plan for the meat industry. Finally, there is a section (13) on the role of governments and other regulatory authorities in meat hygiene.

This publication is intended to guide managers of abattoirs and the meat industry. It will also be of value to veterinarians engaged in meat inspection, with their supervisory roles in meat hygiene. The manual is published in detachable modules and also serves as a training resource.

Characterization of Small Ruminant Breeds in West Asia and North Africa

L. Iñiguez (Ed.)

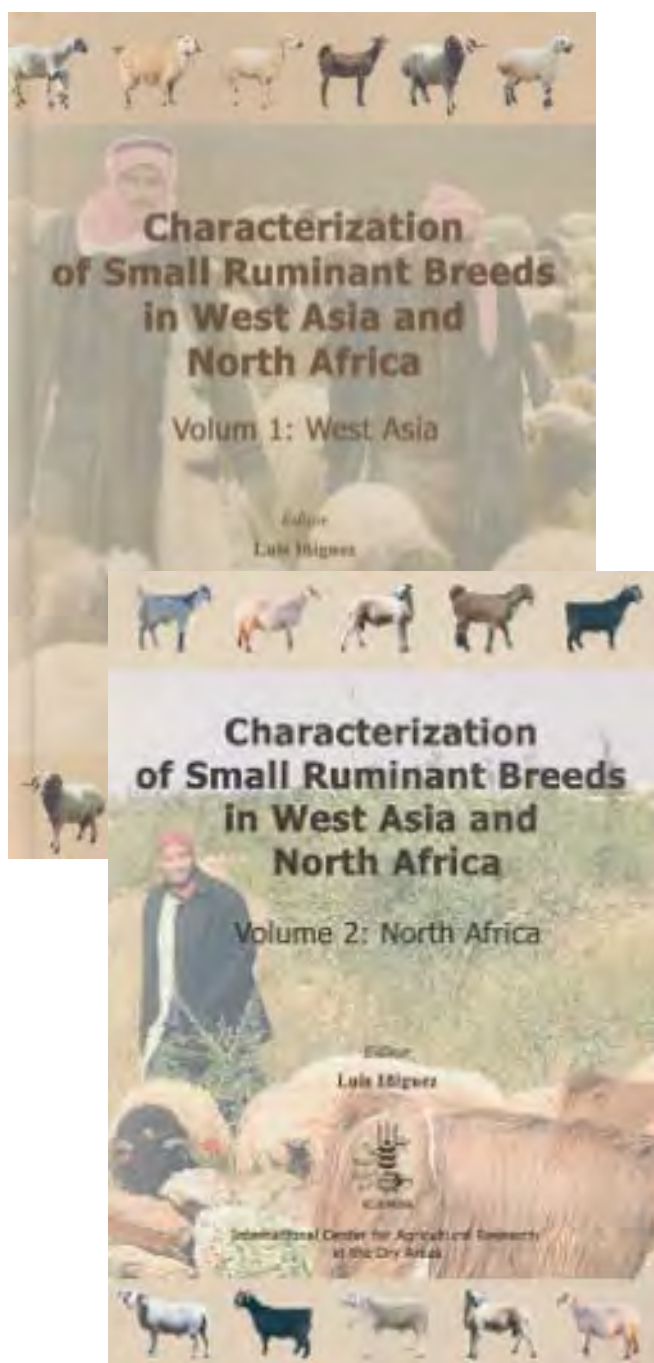
Published by International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria

Published in 2005

Volume 1: West Asia, ISBN: 92-9127-164-9, pp. 462
Volume 2: North Africa, ISBN: 92-9127-177-3, pp. 106

In 2000, ICARDA, with support from CGIAR Inter-Center Working Group for Genetic Resources, commissioned a series of studies to document breeds of sheep and goats in 11 countries in the Near East. The countries included seven from West Asia, Cyprus, Jordan, Iraq, Iran, Lebanon, Syria and Turkey and four from Mediterranean North Africa, Algeria, Egypt, Morocco and Tunisia. Volume 1 of this study is concerned with the countries of West Asia and while Volume 2 deals with North Africa. The books include a chapter on each country prepared by authorities on small ruminants in respective countries, beside an introductory chapter by the Editor on small ruminants in this region. Material in the book has been well structured to follow a skeleton set by the Editor which makes it easy to extract information. The two volumes compile available information on 75 sheep breeds and 32 goat breeds. This information includes characteristics of sheep and goat breeds in term of morphology and performance, development of their populations, description of production systems and how they fit in the whole of agricultural system, effort for their genetic improvement either by selection within the breed or through crossbreeding, any available estimates of genetic parameters and assessment of risk status for each breed. The volumes contain many colored breed photos, illustrations and tables.

Volume 1 is hard-cover while Volume 2 is paperback but both are of high quality production. It is a must reading for those who are concerned with animal genetic resources especially in the Near East.



Animal Production and Natural Resources Utilization in the Mediterranean Area

A. Georgoudis, A. Rosati & C. Mosconi (Eds)

Proc. of the Mediterranean Symposium organised by EAAP, CIHEAM, HSAP and FAO in Ioanina, Greece 5-7 June 2003,

Published in 2005, pp. 624

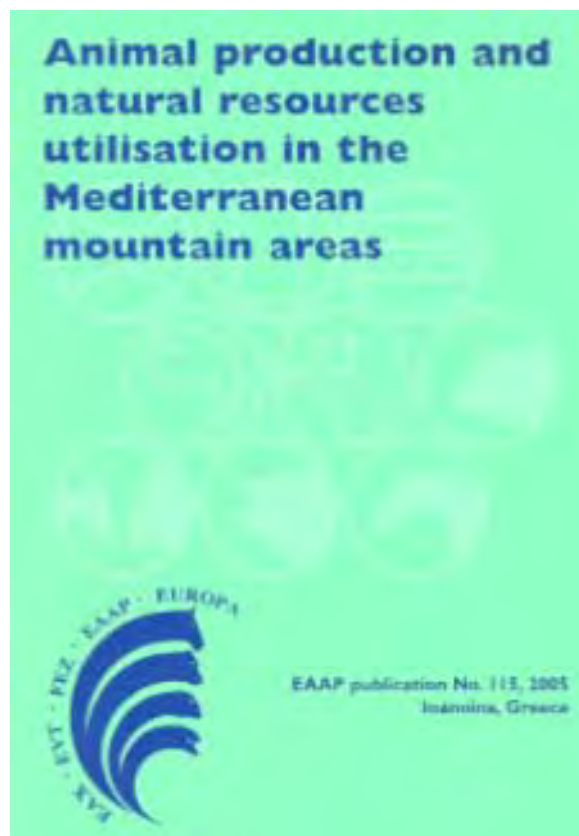
ISBN: 9076998566; ISSN: 0071-2477

Mediterranean mountains contain an integrated complex of natural resources and their inhabitants, depending generally directly on many of these resources for their livelihoods, tend to utilize and manage them through a combination of land-use practices, mainly livestock production and forestry. The specific mountain-related conditions, which the mountain communities face are, the limited land resources, the marginal agricultural conditions, isolation, and scanty equipment and infrastructure. Livestock production and forestry are key sources of income yet are carried out under such harsh conditions.

These products are key to the regions' sustainability. Following such considerations, the main topics discussed among the 300 participants of the symposium held in Ioanina, Greece, were:

1. Human geography of Mediterranean mountain territories, with particular relevance to the importance of human communities, basis of agricultural activity, factors of changes and constraints.
2. Livestock production and natural resources with special emphasis on the characterisation and utilisation of land resources by livestock and sustainable utilisation of forest areas.
3. Improving the efficiency of livestock systems in Mediterranean Mountains. In particular, management, feed resources, genetic resources, productivity, typical products, processing, marketing, traceability, use of biotechnologies, biosecurity, non-trade products, administrative and technical supports.
4. Applications of new technologies for environmentally sound management of livestock and natural resource as the case for the use of GIS, and other technologies.
5. Livestock as a fundamental factor for rural development and safeguard of natural resources with the presentation of specific case studies; the strategies for preservation and valorisation of endogenous culture and traditional knowledge; development of high value-added animal products.

A final Round Table on "Development and support policies for sustaining and promoting the livestock sector in Mountainous areas" concluded the meeting.



**OIE/FAO International Scientific
Conference on Avian Influenza**

A. Schudel & M. Lombard (Eds)

Developments in Biologicals, Vol. 124

Proceedings of an International Conference held in Paris, France, April 2005

Publisher: S. Karger AG, Basel

Published in 2005, pp. 278

ISSN: 1424-6074; ISBN 3-8055-8031-2

This monograph comprises the Proceedings of an International Conference on Avian Influenza held in Paris, France, in April 2005.

The main topics discussed during the conference were the new scientific discoveries in the domain of avian influenza (AI), with special emphasis on the highly pathogenic avian influenza (HPAI).

This publication provides important up-to-date information on the virology, epidemiology and molecular biology as well as the history of episodes of avian influenza in different parts of the world and their consequences.

The publication aims at making recommendations to compare and improve the international procedures and standards related to the identification, prevention, control and elimination of AI epizootics as they are a threat to the livelihood of farmers, especially in developing countries, to public health as well as to national economies.

Chief veterinary officers, animal health regulatory officials, veterinarians, poultry-raising associations, consumer associations, specialised journalists and all those who need to understand and control AI episodes will benefit from reading this book. Indispensable for anyone involved in the burning issue of avian influenza



Lithuanian Native Domestic Animal Breeds

R. Sveistiene (Ed.)

Institute of Animal Science of LVA,

Department of Animal Breeding and Genetics

R. Zebenkos g. 12, LT 82317 Baisogala, Radviliskio r., Lithuania

Published in 2005, pp. 31

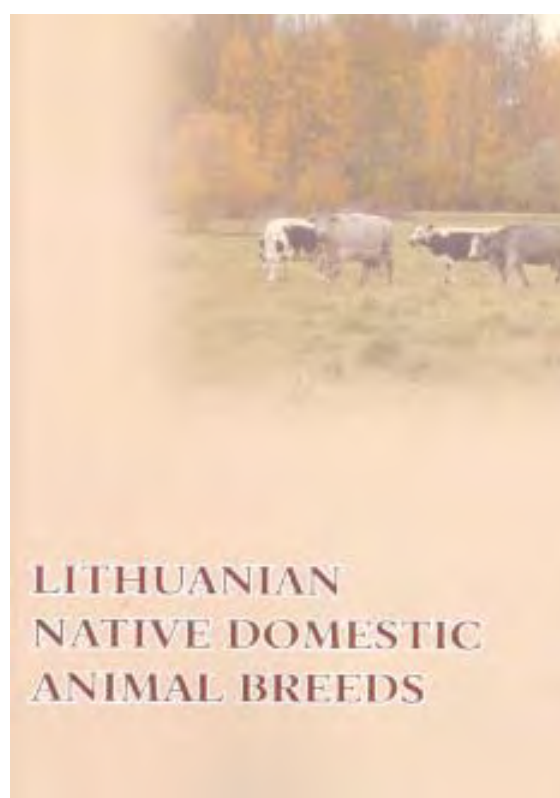
ISBN: 9955-676-22-1

This soft cover publication, written both in Lithuanian and in English, lists some of the indigenous animal and poultry breeds of Lithuania that have become extinct, others, such as Zemaitukai horses, wattle pigs, ash-grey and whitebacked cattle, native sheep, Vistines geese, are on the verge of extinction.

Lithuania committed itself to conservation of its genetic resources by signing the Conservation convention on Biological Diversity in Rio de Janeiro.

The publication is based on the attempts performed in the period 1993-1996 by the Lithuanian Institute of Animal Science (LIAS) in organizing the conservation of the endangered breeds. Several expeditions to the remote parts of the country were organized with the aim to collect and purchase the remaining wattle pigs and Zemaitukai horses. Herds of wattle pigs, Zemaitukai horses, and native sheep, Ash-grey and White-backed cattle were established at the Institute. Vistines geese could be found only in the collections abroad. After purchasing and import of eggs, a small flock of Vistines geese was successfully restored at the Institute. Small groups of Ash-grey and White-backed cattle are kept at the Training Centre of the Lithuanian Veterinary Academy (LVA)

At the end of March, 1995, the FAO Mission Conference for Central and East European countries recognized these breeds as watched internationally. All the indigenous animal and poultry breeds were included into the FAO Global Databank for Animal Genetic Resources and the World



Watch List for Domestic Animal Diversity. On December 21, 1995, the coordinating board for the conservation of domestic animal diversity was set up.

Coloured pictures of each breed make the publication interesting and useful for those interested in local AnGR.

Editorial Policies and Procedures

The mission of the Animal Genetic Resources Information Bulletin (AGRI) is the promotion of information on the better use of animal genetic resources of interest to food and agriculture production, under the Global Strategy for the Management of Farm Animal Genetic Resources. All aspects of the characterization, conservation and utilization of these resources are included, in accordance with the Convention on Biological Diversity. AGRI will highlight information on the genetic, phenotypic and economic surveying and comparative description, use, development and maintenance of animal genetic resources; and on the development of operational strategies and procedures which enable their more cost-effective management. In doing this AGRI will give special attention to contributions dealing with breeds and procedures capable of contributing to the sustainable intensification of the world's medium to low input production environments (agro-ecosystems), which account for the substantial majority of the land area involved in livestock production; the total production of food and agriculture from livestock; and of our remaining farm animal genetic resources.

Views expressed in the paper published in AGRI represent the opinions of the author(s) and do not necessarily reflect those of the institutions which the authors are affiliated, FAO or the Editors.

The suitability of manuscripts for publication in AGRI is judged by the Editors and reviewers.

Electronic publication

AGRI is available in full electronically on the Internet, in addition to being published in hard copy, at:

<< <http://www.fao.org/dad-is>>>

Types of Articles

The following types of articles are published in AGRI.

Research articles

Findings of work on characterization, conservation and utilization of farm animal genetic resources (AnGR) in well described production environments, will be considered for publication in AGRI. Quality photographs of these genetic resources viewed in the primary production environment to which they are adapted, accompanying the manuscripts are encouraged.

Review articles

Unsolicited articles reviewing agro-ecosystems, country-level, regional or global developments on one or more aspects of the management of animal genetic resources, including state-of-the-art review articles on specific fields in AnGR, will be considered for publication in AGRI.

Position papers

Solicited papers on topical issues will also be published as deemed required.

Other published material

This includes book reviews, news and notes covering relevant meetings, training courses and major national, regional and international events and conclusions and recommendations associated with the outcomes of these major events. Readers are encouraged to send such items to the editors.

Guidelines for Authors

Manuscript submission

Manuscripts prepared in English, French or Spanish with an English summary and

another summary in either French or Spanish, should be submitted to AGRI Editor, AGAP, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy. Additionally the manuscript must be sent as a WinWord Electronic Mail attachment to agri-bulletin@fao.org. Photographs, coloured or black and white, and figures must be always sent by mail.

Manuscripts should be typed double-spaced and with lines numbered in the left margin. All pages, including those of references, tables etc., must be consecutively numbered. The corresponding author is notified of the receipt of a manuscript.

For manuscripts that are accepted after revision, authors are encouraged to submit a last version (3½" disc format) in Word 6.0 for Windows of their revised manuscript along with the printed copy.

Preparation of the manuscript

The first page of the manuscript must include the running head (abbreviated title), title, names of authors, institutions, full addresses including postal codes and telephone number and other communication details (fax, e-mail, etc.) of the corresponding author. The running head not exceeding 45 characters plus spaces, should appear at the top of page 1 of the manuscript entirely in capital letters. The title of the manuscript is typed in upper and lower case letters. The title should be as brief as possible not exceeding 150 characters (including spaces) with species names when applicable. Authors, institutions and addresses are in upper and lower case italics. There is one blank line between the title and the authors. Addresses are typed as footnotes to the authors after leaving one blank line. Footnotes are designated numerically. Two lines are left below the footnotes.

Headings

Headings of sections, for example Summary, Introduction, etc., are left-justified. Leave two blank lines between addresses footnotes and Summary and between the heading Summary

and its text. Summary should not exceed 200 words . It should be an objective summary briefly describing the procedures and findings and not simply stating that the study was carried on such and such and results are presented, etc. Leave one line between the summary text and Keywords which is written in italics as well as the keywords themselves. All headings of sections (14 regular) and sub-sections (12 regular) are typed bold and preceded and succeeded by one blank line and their text begins with no indentation. The heading of a sub-subsection is written in italics, and ends with a dot after which the text follows on the same line. Keywords come immediately after the summaries. They should be no more than six, with no "and" or "&".

Tables and figures

Tables and figures must be enclosed with the paper and attached at the end of the text according their citation in the document. Photos will not be returned

Tables

Tables, including footnotes, should be preceded and succeeded by 2 blank lines. Table number and caption are written, above the table, in italics (12) followed by a dot, then one blank line. For each column or line title or sub-title, only the 1st letter of the 1st word is capitalized. Tables should be numbered consecutively in Arabic numerals. Tables and captions should be left justified as is the text. Use horizontal or vertical lines only when necessary. Do not use tabs or space-bar to create a table but only the appropriate commands.

Figures

Figures including titles and legends should be preceded and succeeded by two blank lines. Figure number and title are written, below the figure, in italics (12) and end with a dot. The term figures includes photos, line drawings,

maps, diagrams etc.

All the submitted diagrams, must be accompanied with the original matrix of the data used to create them. It is strongly advised to submit diagrams in Word 6.0 or Excel 5.0. Figures should be numbered consecutively in Arabic numerals.

References

Every reference cited in the text should be included in the reference list and every reference in the reference list should have been mentioned in the text at least once. References should be ordered firstly alphabetically by the first author's surname and secondly by year.

- Example for reference in a periodical is: Köhler-Rollefson, I. 1992. The camel breeds of India in social and historical perspective. *Animal Genetic Resources Information* 10, 53-64.
- When there are more than one author: Matos, C.A.P., D.L. Thomas, D. Gianola, R.J. Tempelman & L.D. Young. 1997. Genetic analysis of discrete reproductive

traits in sheep using linear and nonnlinear models: 1. Estimation of genetic parameters 75, 76-87.

- For a book or an ad hoc publication, e.g., reports, theses, etc.: Cockrill, W.R. (Ed.). 1994. *The Husbandry and Health of the Domestic Buffalo*. FAO, Rome, Italy, pp 993.
- For an article in the proceedings of a meeting: Hammond, K. 1996. FAO's programme for the management of farm animal genetic resources. In C. Devendra (Ed.), *Proceedings of IGA/FAO Round Table on the Global Management of Small Ruminant Genetic Resources*, Beijing, May 1996, FAO, Bangkok, Thailand, 4-13.
- Where information included in the article has been obtained or derived from a World Wide Web site, then quote in the text, e.g. "derived from FAO. 1996" and in the References quote the URL standard form: FAO. 1996. Domestic Animal Diversity Information System, <http://www.fao.org/dad-is/>, FAO, Rome, Italy.

For all future manuscript dispatch and correspondence regarding AGRI, please use the following mailbox:

agri-bulletin@fao.org

Thanks for the collaboration

Normes et règles éditoriales

L'objectif du Bulletin d'information sur les ressources génétiques animales (AGRI) est la vulgarisation de l'information disponible sur la meilleure gestion des ressources génétiques animales d'intérêt pour la production alimentaire et agricole, d'après les recommandations de la Stratégie mondiale pour la gestion des ressources génétiques des animaux domestiques. Tous les aspects relatifs à la caractérisation, la conservation et l'utilisation de ces ressources seront pris en considération, suivant les normes de la Convention pour la Biodiversité.

AGRI désire diffuser de l'information sur la génétique, les enquêtes phénotypiques et économiques et les descriptions comparatives, l'utilisation et la conservation des ressources génétiques animales, ainsi que toute information sur le développement de stratégies opérationnelles et de normes qui puissent permettre une meilleure gestion de la relation coût/efficacité. C'est pour cela que AGRI prendra spécialement en considération toutes les contributions référées aux races et aux normes capables de permettre une intensification durable des milieux (agroécosystèmes) à revenus moyens et bas dans le monde; qui comprennent la majeure partie des terres consacrées à l'élevage, à la production totale des aliments et l'agriculture provenant de l'élevage; et tout ce qui reste comme ressources génétiques des animaux domestiques.

Les opinions exprimées dans les articles publiés dans AGRI appartiennent seulement aux auteurs et donc ne représentent pas nécessairement l'opinion des instituts pour lesquels ils travaillent, la FAO ou les éditeurs.

L'opportunité ou non de publier un article dans AGRI sera jugée par les éditeurs et les réviseurs.

Publication électronique

En plus de sa version imprimée, la version totale de AGRI se trouve disponible sur Internet, sur le site:

<http://www.fao.org/dad-is/>

Types d'articles

Les articles suivants pourront être publiés sur AGRI:

Articles de recherche

Seront prises en considération pour leur publication sur AGRI les études sur la caractérisation, la conservation et l'utilisation des ressources génétiques des animaux domestiques (AnGR) accompagnées d'une bonne description du milieu. On encourage les auteurs à envoyer des photographies de bonne qualité qui montrent les races en question dans leur milieu naturel de production.

Révisions

Occasionnellement, des articles contenant une révision des agroécosystèmes, au niveau national, régional ou mondial, avec un ou plusieurs aspects se rapportant à la gestion des ressources génétiques animales, y compris les mises à jour des différentes zones de AnGR, seront pris en considération.

Articles spécifiques

Ponctuellement, des articles sur des thèmes spécifiques pourront être demandés pour la publication d'éditions spéciales.

Autre matériel pour publication

Ceci comprend la révision de livres, nouvelles et notes de réunions importantes, cours de formation et principaux événements nationaux, régionaux et internationaux; ainsi que les conclusions et recommandations par rapport aux objectifs de ces principaux événements. Les auteurs sont priés d'envoyer ce genre de matériel aux éditeurs.

Guide pour les auteurs

Présentation du manuscrit

Les articles se présenteront en anglais, français ou espagnol, avec un résumé en anglais et sa traduction en français ou en espagnol; ils seront envoyés à l'éditeur de AGRI, AGAP, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italie. En outre, l'article devra être envoyé par courrier électronique comme document attaché en version WinWord à *agri-bulletin@fao.org*. Les photographies, en couleur ou en blanc et noir, seront toujours envoyées par courrier normal.

Les manuscrits se présenteront à double interligne et avec le numéro correspondant à chaque ligne sur la marge gauche. Toutes les pages seront numérotées, y compris celles avec les références bibliographiques, les tableaux, etc. L'auteur recevra une lettre lui donnant bonne réception de son document.

Lorsqu'un article, après sa révision, sera accepté, on demandera à l'auteur d'envoyer la version finale révisée sur disquette (format 3 1/2") en Word 6.0 x Windows, ainsi qu'une copie sur papier.

Préparation du manuscrit

Sur la première page du manuscrit on indiquera le titre de l'article en abrégé, le titre et noms des auteurs, des institutions, les adresses complètes (y compris code postal et numéro de téléphone); ainsi que tout autre moyen de contact tel que télécopie, courriel, etc. avec l'auteur principal. Le titre abrégé ne devra pas dépasser 45 caractères, plus les espaces nécessaires, et s'écrit sur la partie supérieure de la page 1 du manuscrit en majuscules. Le titre en entier du manuscrit sera écrit en majuscules et minuscules; il devra être aussi bref que possible, sans dépasser 150 caractères (y compris les espaces nécessaires), et avec l'indication des noms des espèces. Les noms des auteurs, des institutions et les adresses seront en italique et en lettres majuscules et minuscules. On laissera un espace en blanc entre le titre et les

noms des auteurs. Les adresses seront indiquées comme de bas à pied de page pour chacun des auteurs après avoir laissé un espace en blanc après les noms. Chaque note de bas de page sera numérotée. On laissera deux espaces en blanc après les adresses.

Titres

Les titres de chaque chapitre, par exemple Résumé, Introduction, etc. seront alignés à gauche. Laisser deux espaces en blanc entre les notes de bas de page avec les adresses et le Résumé, et entre le titre Résumé et le texte qui suit. Le résumé ne devra pas dépasser les 200 mots. Il s'agira d'un résumé objectif faisant une brève description des processus utilisés et des résultats obtenus, et non pas une simple présentation du travail réalisé avec une description générale des résultats. Laisser un espace en blanc entre la fin du texte du résumé et les mots clés, qui seront écrits en italique ainsi que le titre Mots clés. Les mots clés seront au maximum six et il ne devra pas y avoir de et ou &. Tous les titres principaux de chapitre (14 regular) et sous-chapitre (12 regular) seront en gras avec un espace en blanc avant et après. Le texte commencera sans retrait. Un titre à l'intérieur d'un sous-chapitre s'écrit en italique, suivi d'un point, avec le texte à continuation.

Tableaux et figures

Les tableaux et les figures iront à la fin du texte en suivant l'ordre d'apparition dans le texte. Les photographies ne seront pas dévolues aux auteurs.

Tableaux

Les tableaux, y compris les notes de bas de page, devront avoir un espace en blanc avant et après. Le numéro du tableau et le titre s'écrit sur la partie supérieure en italique (12) avec un point à la fin et un espace en blanc en dessous. Sur chaque colonne, titre d'en-tête ou sous-titre, seulement la première lettre du premier mot sera en majuscule. Les tableaux et leur titre seront alignés à gauche,

ainsi que le texte. Les lignes verticales et horizontales seront utilisées seulement si nécessaire. Ne pas utiliser les "tabs" ou la barre d'espacement pour créer un tableau.

Figures

Les figures, y compris les titres et les légendes, seront précédés et suivis de deux espaces en blanc. Le numéro de la figure et le titre s'écriront sur la partie supérieure en italique (12) avec un point à la fin. Sous la rubrique figure on trouvera les photographies, les graphiques, les cartes, les diagrammes, etc. Dans le cas des diagrammes, la matrice originale avec les données utilisées pour son élaboration devra être envoyée. On recommande l'utilisation de Word 6.0 ou Excel 5.0 pour la présentation des diagrammes.

Références

Toute référence présente dans le texte devra apparaître sur la liste des références, et chaque référence de la liste aura été citée au moins une fois dans le texte. Les références iront en ordre alphabétique du nom de l'auteur, suivi de l'année.

- Exemple dans le cas d'une référence sur une revue:
Köhler-Rollefson, I. 1992. The camel breeds of India in social and historical perspective. *Animal Genetic Resources Information* 10, 53-64.

- Lorsqu'il s'agit de plus d'un auteur:
Matos, C.A.P., D.L. Thomas, D. Gianola, R.J. Tempelman & L.D. Young. 1997. Genetic analysis of discrete reproductive traits in sheep using linear and nonlinear models: 1. Estimation of genetic parameters 75, 76-87.
- Dans le cas d'un livre ou d'une publication ad hoc, par exemple un rapport, une thèse, etc.:
Cockrill, W.R. (Ed.). 1994. *The Husbandry and Health of the Domestic Buffalo*. FAO, Rome, Italy, pp 993.
- S'il s'agit d'un acte d'une réunion:
Hammond, K. 1996. FAO's programme for the management of farm animal genetic resources. In C. Devendra (Ed.), *Proceedings of IGA/FAO Round Table on the Global Management of Small Ruminant Genetic Resources*, Beijing, May 1996, FAO, Bangkok, Thailand, 4-13.
- Lorsque l'information contenue dans l'article ait été obtenue ou dérive d'un site World Wide Web, il faudra mettre le texte entre guillemets; par exemple "tiré de la FAO. 1996" et indiquer dans les Références la forme standard URL:
FAO. 1996. *Domestic Animal Diversity Information System*, <http://www.fao.org/dad-is/>, FAO, Rome, Italy.

Pour tout envoi de manuscripts ou correspondance au sujet d'AGRI, vous êtes prié d'utiliser l'adresse suivante:

agri-bulletin@fao.org

Merci pour votre collaboration

Reglas y normas editoriales

El objetivo del Boletín de Información sobre Recursos Genéticos Animales (AGRI) es la divulgación de la información sobre una mejor gestión de los recursos genéticos animales de interés para la producción alimentaria y agrícola, siguiendo la Estrategia Mundial para la Gestión de los Recursos Genéticos de los Animales Domésticos. Todos los aspectos referidos a la caracterización, la conservación y el uso de estos recursos serán tomados en consideración, de acuerdo con el Convenio sobre la diversidad biológica.

AGRI publicará información sobre genética, encuestas fenotípicas y económicas y descripciones comparativas, uso, desarrollo y conservación de los recursos genéticos animales, así como sobre el desarrollo de estrategias operacionales y normas que permitan una gestión más eficaz de la relación costo / eficacia. Por ello, AGRI prestará especial atención a las contribuciones referidas a razas y normas capaces de contribuir a la intensificación sostenible de los medios (agroecosistemas) con ingresos medios y bajos en el mundo, que comprenden casi la mayor parte de las tierras dedicadas a la producción ganadera; la producción total de alimentos y agricultura provenientes de la ganadería; y el resto de los recursos genéticos de animales domésticos.

Los puntos de vista expresados en los artículos publicados en AGRI son solamente las opiniones de los autores y, por tanto, no reflejan necesariamente la opinión de las instituciones para las cuales trabajan dichos autores, de la FAO o de los editores.

La oportunidad o no de publicar un artículo en AGRI será juzgada por los editores y revisores.

Publicación electrónica

Además de su publicación impresa, la versión íntegra de AGRI se encuentra disponible electrónicamente en Internet, en el sitio: www.fao.org/dad-is/

Tipos de artículos

Serán publicados en AGRI los siguientes tipos de artículos:

Artículos sobre investigación

Se tomarán en consideración para su publicación en AGRI los estudios sobre la caracterización, conservación y uso de los recursos genéticos de los animales domésticos (AnGR) con una buena descripción del entorno. Se agradecerá el envío de fotografías de calidad que presenten a las razas en cuestión en su ambiente natural de producción.

Artículos de revisión

Se podrán tomar en consideración ocasionalmente aquellos artículos que presenten una revisión de los agroecosistemas, a nivel nacional, regional o mundial, con el desarrollo de uno o más aspectos referidos a la gestión de los recursos genéticos animales, incluidas las revisiones sobre el estado actual de las distintas áreas de AnGR.

Artículos específicos

Se solicitarán puntualmente artículos sobre temas específicos para ediciones especiales.

Otro material para publicación

Incluye la revisión de libros, noticias y notas referidas a reuniones importantes, cursos de formación y principales eventos nacionales, regionales e internacionales, así como conclusiones y recomendaciones relacionadas con los objetivos de estos principales eventos. Se invita a los lectores a enviar este tipo de material a los editores.

Guía para los autores

Presentación del manuscrito

Los artículos se presentarán en inglés, francés o español, junto con un resumen en inglés y su traducción en francés o español, y se enviarán al editor de AGRI, AGAP, FAO, Viale delle Terme di Caracalla, 00100 Roma, Italia. El artículo deberá ser enviado en versión WinWord en fichero adjunto por correo electrónico a agri-bulletin@fao.org. Las fotografías, color o en blanco y negro, se enviarán siempre por correo normal.

Los manuscritos se presentarán con doble espacio y con el número correspondiente a cada línea en el margen izquierdo. Todas las páginas serán numeradas, incluidas las de las referencias bibliográficas, cuadros, etc. El autor recibirá una notificación sobre la recepción de su documento.

En el caso de aceptación de un artículo después de su revisión, se solicitará al autor una versión final de su artículo revisado en disquete (formato 31/2") en Word 6.0 x Windows, así como una copia impresa del mismo.

Preparación del manuscrito

En la primera página del manuscrito se indicará el título abreviado del artículo, títulos y nombres de los autores, instituciones, direcciones completas (incluido código postal y número de teléfono); así como otros medios de contacto tales como fax, correo electrónico, etc. del autor principal. El título abreviado no deberá sobrepasar los 45 caracteres más los espacios correspondientes, y aparecerá en la parte superior de la página 1 del manuscrito en mayúsculas. El título entero del manuscrito se escribirá en mayúsculas y minúsculas. Dicho título debe ser lo más breve posible y no sobrepasar los 150 caracteres (incluidos los espacios necesarios), con los nombres de las especies, si necesario. Los nombres de los autores, instituciones y direcciones se escribirán en cursiva y en letras mayúsculas y minúsculas. Se dejará una línea en blanco

entre el título y los nombres de los autores. Las direcciones se escribirán como notas de pie de página de cada autor después de dejar una línea en blanco entre los nombres y éstas. Cada nota de pie de página con la dirección será indicada numéricamente. Se dejarán dos líneas en blanco después de las direcciones.

Títulos

Los títulos de cada sección, por ejemplo Resumen, Introducción, etc., serán alineados a la izquierda. Dejar dos líneas en blanco entre las notas de pie de página con las direcciones y el Resumen y entre el título Resumen y el texto que sigue. El resumen no deberá exceder de 200 palabras. Deberá ser un resumen objetivo que describa brevemente los procesos y logros obtenidos, y no una presentación de cómo se ha llevado a cabo el estudio y una descripción genérica de los resultados. Dejar una línea en blanco entre el final del texto del resumen y las palabras clave, que se escribirán en cursiva así como el título Palabras clave. No deberán ser más de seis y no deberán contener "y" o "&". Todos los títulos principales de capítulo (14 regular) y subcapítulo (12 regular) serán en negrita e irán precedidos y seguidos de una línea en blanco. El texto correspondiente empezará sin sangrado. Un título dentro de un subcapítulo se escribirá en cursiva e irá seguido de un punto con a continuación el texto correspondiente.

Cuadros y figuras

Los cuadros y las figuras se incluirán al final del texto siguiendo el orden de cita dentro del mismo. Las fotografías no serán devueltas a sus autores.

Cuadros

Los cuadros, incluidas las notas de pie de página, deberán ir precedidos y seguidos por dos líneas en blanco. El número del cuadro y su título se escribirán en la parte superior en cursiva (12) con un punto al final y seguido

de una línea en blanco. En cada columna o título de encabezamiento o subtítulo, sólo la primera letra de la primera palabra irá en mayúscula. Los cuadros irán numerados de forma consecutiva con números árabes. Los cuadros y sus títulos se alinearán a la izquierda, así como el texto. Se utilizarán líneas horizontales o verticales sólo cuando sea necesario. No utilizar tabuladores o la barra espaciadora para crear un cuadro.

Figuras

Las figuras, incluidos los títulos y leyendas, irán precedidas y seguidas de dos líneas en blanco. El número de la figura y el título se escribirán en la parte superior en cursiva (12) con un punto al final. La palabra figura incluye las fotografías, los gráficos, los mapas, los diagramas, etc. En el caso del diagrama se enviará la matriz original con los datos utilizados para crearlo. Se recomienda encarecidamente la utilización de Word 6.0 o Excel 5.0 para la presentación de los diagramas.

Referencias

Toda referencia presente en el texto deberá aparecer en la lista de referencias y, de la misma manera, cada referencia de la lista deberá haber sido citada por lo menos una vez en el texto. Las referencias deben ir en orden alfabético del apellido del autor, seguido por el año.

- Ejemplo en el caso de una referencia de una revista:
Köhler-Rollefson, I. 1992. The camel breeds of India in social and historical perspective. *Animal Genetic Resources Information* 10, 53-64.
- Cuando se trate de más de un autor:
Matos, C.A.P., D.L. Thomas, D. Gianola, R.J. Tempelman & L.D. Young. 1997. Genetic analysis of discrete reproductive traits in sheep using linear and nonnlinear models: 1. Estimation of genetic parameters 75, 76-87.
- En el caso de un libro o de una publicación ad hoc, por ejemplo informes, tesis, etc.:
Cockrill, W.R. (Ed.). 1994. *The Husbandry and Health of the Domestic Buffalo*. FAO, Rome, Italy, pp 993.
- Cuando se trate de un artículo dentro de las actas de una reunión:
Hammond, K. 1996. FAO's programme for the management of farm animal genetic resources. In C. Devendra (Ed.), *Proceedings of IGA/FAO Round Table on the Global Management of Small Ruminant Genetic Resources*, Beijing, May 1996, FAO, Bangkok, Thailand, 4-13.
- Cuando la información contenida en el artículo haya sido obtenida o derive de un sitio World Wide Web, poner el texto entre comillas; por ejemplo "sacado de la FAO. 1996" e indicar en las Referencias la forma estándar URL:
FAO. 1996. Domestic Animal Diversity Information System, <http://www.fao.org/dad-is/>, FAO, Rome, Italy.

Se ruega enviar los manuscritos o la correspondencia relativa a AGRI a la dirección siguiente:

agri-bulletin@fao.org

Gracias por su colaboración